Agnel Charities'

Fr. C. Rodrigues Institute of Technology

Sector 9A, Vashi, Navi Mumbai, 400703, Maharashtra, India

www.fcrit.ac.in

An Autonomous Institute Affiliated to the University of Mumbai

Department of Electronics & Telecommunication Engineering

Curriculum Structure FY to B.Tech

and

First Year & Second Year Syllabi

Prepared by : Board of Studies for Department of Electronics & Telecommunication Engineering

Approved By: Academic Council of Fr. C. Rodrigues Institute of Technology

Revision: 2024.1

Effective from: AY 2024-25

PREAMBLE FROM DEAN (ACADEMICS)

Accelerating Towards Excellence: Unveiling a New Era in Education

Dear Students, Faculty, and Stakeholders,

It is with great pleasure and anticipation that we introduce the newly designed curriculum for autonomy at Agnel Charities' Fr. C. Rodrigues Institute of Technology. This pioneering initiative aims to revolutionize engineering education, ensuring our graduates are equipped with not only technical prowess but also the holistic skills necessary for thriving in today's dynamic professional landscape.

1. **Purpose of Autonomy:** Our commitment to autonomy is rooted in the imperative to bridge the gap between academia and industry. We envision education as a catalyst for individual growth, fostering self-sustainability and enhancing employability. Through our curriculum, westrive to nurture engineers who not only excel in their fields but also contribute meaningfullyto society.

2. **Curriculum Design: A Top-to-Down Approach:** Our curriculum is meticulously crafted with a top-to-down approach, encompassing all 12 attributes of Program Outcomes mandated by regulatory bodies. Emphasizing a blend of theoretical knowledge and practical application, it is designed to cultivate well-rounded professionals capable of tackling real-world challenges with confidence and competence.

3. **Alignment with National Education Policy-2020:** In adherence to the guidelines laid out in the National Education Policy-2020, our curriculum embodies a multidisciplinary approach, offering a diverse array of core and elective courses. It integrates hands-on learning experiences such as mini and major projects, skill-based labs, and one-semester internships to nurture innovation and problem-solving skills. Additionally, the inclusion of value-added courses, honours, and minors ensures a comprehensive educational journey tailored to individual interests and aspirations.

4. **Opportunities for Teachers in Innovation:** We recognize the pivotal role of our faculty in shaping the educational experience. Our curriculum provides ample opportunities for teachers to innovate in teaching-learning methodologies and evaluation techniques. Throughcontinuous professional development programs and collaborative platforms, we empower our educators to experiment with innovative pedagogies, leverage technology for enhanced learning outcomes, and implement novel assessment strategies. By fostering a culture of innovation among our faculty, we aim to enrich the learning experience and inspire a passionfor lifelong learning among our students.

As we embark on this transformative journey, we invite all stakeholders to join us in shaping the futureof engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

Dean of Academics Agnel Charities' Fr. C. Rodrigues Institute of Technology

PREAMBLE FROM CHAIRPERSON (BoS)

Dear Students, Faculty, and Stakeholders,

It is with great pleasure and anticipation that we introduce the newly designed curriculum for autonomy at the Department of Electronics & Telecommunication (EXTC) engineering, Agnel Charities' Fr. C. Rodrigues Institute of Technology. This pioneering initiative aims to adapt to changing needs of the society, foster excellence, and drive innovation, thereby contributing to the nation's technological advancement and global competitiveness.

The Department has followed a top-down approach, for curriculum design. The steps include consultation with stakeholders; mapping outcomes to courses; setting learning objectives which are clear and measurable; designing the content aligned with the learning objectives; selection of instructional material, activities, and assessment tools to support the alignment, integration of experiential learning through projects, skill laboratories, internships, and industry collaboration; and set the stage for continuous evaluation and improvement. The consultation with Industry partners has enabled to identify requirements of Industry and to introduce four Honours/minor tracks, namely, VLSI, IoT & Embedded Systems, AIML and Network Security. The current trends in Industry have been taken into consideration while designing the content of core courses, laboratory courses, program electives as well as Honours/minor courses. The recent impetus to the semiconductor program in India has motivated us to include courses like Electronic Devices & Circuits, CMOS Design, ASIC Design, System on Chip Design etc which will certainly make our graduates ready for the semiconductor industry.

In alignment with the transformative vision laid out in the National Education Policy (NEP) 2020, our curriculum is designed to empower students with a comprehensive understanding of core domains like electronics, communication, and signal processing. Through multi-disciplinary courses, skill laboratories and exclusively designed laboratory courses, students develop the skills required to address complex challenges. Practical engineering aspects like Image Processing & Machine Vision, Antenna Design, High Frequency Communication etc are introduced through stand-alone laboratory courses. The curriculum caters to diversity in learners' choices by offering program electives in different fields like Microwave engineering/ Optical Fiber Communication/ Satellite & nano-satellite Communication/Digital TV Engineering etc.

In the autonomous curriculum, teachers have numerous opportunities to innovate and enhance the educational experience for students. Teachers actively participate in designing the curriculum, tailoring it to suit the needs of students and aligning it with industry trends and emerging technologies. Teachers can engage in research and development activities and offer Internships to explore new areas. Teachers can foster partnerships with industry organizations to enrich the curriculum with industry-relevant projects, internships, and guest lectures. Overall, autonomy in curriculum aims to empower the teachers to play a central role in shaping the learning experiences of students, in the field of Electronics & Telecommunication Engineering.

Thus, by nurturing creativity, resilience, and a spirit of inquisitiveness, we aspire to empower our graduates to become leaders, innovators, and global ambassadors of excellence in the field of electronics and telecommunication engineering. As we embark on this transformative journey, we invite all stakeholders to join us in shaping the future of engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

Chairperson, Board of Studies-Electronics & Telecommunication Engineering,
Agnel Charities' Fr. C. Rodrigues Institute of Technology

Contents

Sr. No.	Item	Page Number
A.	Abbreviations	5
B.	Credit Structure	6
C.	Curriculum Structure	7
D.	Multidisciplinary Minor Courses	23
E.	Honours, Minor, and Honours in Reseach Degree Program	24
F.	First Year Syllabi	25
G.	Second Year Syllabi	156
H.	Third Year Syllabi	266

B. Credit Structure

1. B. Tech in Electronics & Telecommunication Engineering											
Type of Course	**Semester-wise Credit Distribution**									**FCRIT Credit Distribution**	**DTE Credit Distribution**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**		
Basic Science Course (BSC)	08	08	--	--	--	--	--	--	**16**	**18**	**14-18**
Basic Science Laboratory Course (BSL)	01	01	--	--	--	--	--	--	**02**		
Engineering Science Course (ESC)	05	02	--	--	--	--	--	--	**07**	**16**	**12-16**
Engineering Science Laboratory Course (ESL)	04	05	--	--	--	--	--	--	**09**		
Program Core Course (PCC)	--	--	14	13	06	03	03	--	**39**	**50**	**44-56**
Laboratory Course (LBC)	--	--	02	03	02	02	02	--	**11**		
Program Elective (PEC)	--	--	--	--	03	03	06	03	**15**	**15**	**20**
Multidisciplinary Minor (MDM)	--	--	03	03	03	04	—	--	**13**	**13**	**14**
Multidisciplinary Laboratory Course (MDL)†	--	--	--	--	01	--	--	--	**01**	**01**	
Open Elective (OEC)	--	--	--	--	--	--	03	03	**06**	**06**	**08**
Skill Enhancement Course (SEC)	01	01	--	--	--	--	--	--	**02**	**08**	**08**
Skill Based Laboratory (SBL)	--	--	02	02	--	02	--	--	**06**		
Ability Enhancement Course (AEC)	--	03	--	--	02	--	--	--	**05**	**05**	**04**
Humanities Social Sciences and Management (HSS)	--	--	02	--	02	--	02	--	**06**	**06**	**04**
Indian Knowledge System (IKS)	--	02	--	--	--	--	--	--	**02**	**02**	**02**
Value Education Course (VEC)	02	--	--	02	--	--	--	--	**04**	**04**	**04**
Experiential Learning Course (ELC)	--	--	--	--	--	02	--	--	**02**	**02**	**04**
Mini Project (MNP)	--	--	01	01	01	01	--	--	**04**	**10**	**04**
Major Project (MJP)	--	--	--	--	--	--	02	04	**06**		
Internship (INT)	--	--	--	--	--	--	--	08	**08**	**08**	**12**
Liberal Learning Course (LLC)	--	--	--	--	--	02	--	---	**02**	**02**	**04**
Total Credits	**21**	**22**	**24**	**24**	**20**	**19**	**18**	**18**	**166**	**166**	**160-176**

C Curriculum Structure and Examination Scheme for B. Tech in Electronics & Telecommunication Engineering

(FY and SY with Effect from AY 2024-2025)
Curriculum Structure – FY Semester-I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
BSC101	Engineering Mathematics I	4	--	--	--	--	--	4
BSC102	Engineering Physics-I	2	--	--	2	--	--	2
BSC103	Engineering Chemistry-I	2	--	--	2	--	--	2
ESC101	Engineering Mechanics	3	--	--	3	--	--	3
ESC102	Basic Electrical Engineering	2	--	--	2	--	--	2
BSL101	Engineering Physics-I Laboratory	--	1	--	--	0.5	--	0.5
BSL102	Engineering Chemistry-I Laboratory	--	1	--	--	0.5	--	0.5
ESL101	Engineering Mechanics Laboratory	--	2	--	--	1	--	1
ESL102	Basic Electrical Engineering Laboratory	--	2	--	--	1	--	1
ESL103	Programming Laboratory-I (C)	--	2*+2	--	--	2	--	2
SEC101	Basic Workshop Practice-I	--	2	--	--	1	--	1
VEC101	Universal Human Values	2	--	--	2	--	--	2
Total		**14**	**12**	**1**	**14**	**6**	**1**	**21**

*** Instructions should be conducted for the entire class.**

NOTE 1: Compulsory Non-Credit Activities: Participation and/or coordination of co-curricular and extra-curricular events at the Institute or Department level is mandatory for all students from semesters 1 to 8 as part of non-credit liberal education. Please consult the department's Curriculum Book for more information. These activities do not yield credits. Upon successful participation or organization of activities, a certificate will be awarded at the conclusion of semester 8.

NOTE 2: Please note that during semesters 1 to 8 some of the non-technical courses such as Humanities Social Sciences and Management (HSSM), Open Electives (OE), Value Education Course (VEC), and Liberal Learning Course (LLC) may be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.

Examination Scheme – FY Semester-I

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC101	Engineering Mathematics-I	20+25@	30	50	1.5	2	125
BSC102	Engineering Physics-I	15	20	40	1.0	1.5	75
BSC103	Engineering Chemistry-I	15	20	40	1.0	1.5	75
ESC101	Engineering Mechanics	20	30	50	1.5	2	100
ESC102	Basic Electrical Engineering	15	20	40	1.0	1.5	75
BSL101	Engineering Physics-I Laboratory	25	--	--	--	--	25
BSL102	Engineering Chemistry-I Laboratory	25	--	--	--	--	25
ESL101	Engineering Mechanics Laboratory	25	--	--	--	--	25
ESL102	Basic Electrical Engineering Laboratory	25	--	25	--	--	50
ESL103	Programming Laboratory-I (C)	50	--	50	--	--	100
SEC101	Basic Workshop Practice-I	50	--	--	--	--	50
VEC101	Universal Human Values	50	--	--	--	--	50
	Total	**360**	**120**	**295**	--	--	**775**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – FY Semester-II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
BSC204	Engineering Mathematics-II	4	--	--	--	--	--	4
BSC205	Engineering Physics-II	2	--	--	2	--	--	2
BSC206	Engineering Chemistry-II	2	--	--	2	--	--	2
AEC201	Professional Communication and Ethics-I	2	2	--	2	1	--	3
ESC203	Basic Electronics Engineering	2	--	--	2	--	--	2
BSL203	Engineering Physics-II Laboratory	--	1	--	--	0.5	--	0.5
BSL204	Engineering Chemistry-II Laboratory	--	1	--	--	0.5	--	0.5
ESL204	Engineering Graphics Laboratory	--	2*+2	--	--	2	--	2
ESL205	Programming Laboratory-II (Java)	--	2*+2	--	--	2	--	2
ESL206	Basic Electronics Engineering Laboratory	--	2	--	--	1	--	1
SEC202	Basic Workshop Practice-II	--	2	--	--	1	--	1
IKS201	Indian Knowledge System	2	--	--	2	--	--	2
	Total	**13**	**16**	**1**	**13**	**8**	**1**	**22**

*** Instructions should be conducted for the entire class.**

Examination Scheme – FY Semester-II

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC204	Engineering Mathematics-II	20+25@	30	50	1.5	2	125
BSC205	Engineering Physics-II	15	20	40	1.0	1.5	75
BSC206	Engineering Chemistry-II	15	20	40	1.0	1.5	75
AEC201	Professional Communication and Ethics-I	50	--	--	--	--	50
ESC203	Basic Electronics Engineering	15	20	40	1.0	1.5	75
BSL203	Engineering Physics-II Laboratory	25	--	--	--	--	25
BSL204	Engineering Chemistry-II Laboratory	25	--	--	--	--	25
ESL204	Engineering Graphics Laboratory	50	--	50	--	--	100
ESL205	Programming Laboratory-II (Java)	50	--	50	--	--	100
ESL206	Basic Electronics Engineering Laboratory	25	--	25	--	--	50
SEC202	Basic Workshop Practice-II	50	--	--	--	--	50
IKS201	Indian Knowledge System	50	--	--	--	--	50
	Total	**415**	**90**	**295**	--	--	**800**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – SY Semester-III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPCC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ECPCC302	Network Theory	3	--	1	3	--	1	4
ECPCC303	Electronic Devices and Circuits	3	--	--	3	--	--	3
ECPCC304	Digital Circuit Design	3	--	--	3	--	--	3
XXMDM301	--	3	--	--	3	--	--	3
ECLBC301	Electronic Devices and Circuits Laboratory	--	2	--	--	1	--	1
ECLBC302	Digital Circuit Design Laboratory	--	2	--	--	1	--	1
ECSBL301	Python Laboatory	--	4	--	--	2	--	2
ECMNP301	Mini Project-1A	--	3	--	--	1	--	1
HSS301	Product Design	2	--	--	2	--	--	2
	Total	**17**	**11**	**2**	**17**	**5**	**2**	**24**

Note : Four theory courses (Three 3-credit and one 4-credit) and One Laboratory course (1-credit) offered by other department has to be taken by EXTC students, to complete the 14-credit requirement for MDM.

Examination Scheme – SY Semester-III

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECPCC301	Engineering Mathematics-III	20+25@	30	50	1.5	2	125
ECPCC302	Network Theory	20+25@	30	50	1.5	2	125
ECPCC303	Electronic Devices and Circuits	20	30	50	1.5	2	100
ECPCC304	Digital Circuit Design	20	30	50	1.5	2	100
XXMDM301	--	20	30	50	1.5	2	100
ECLBC301	Electronic Devices and Circuits Laboratory	25	--	25	--	--	50
ECLBC302	Digital Circuit Design Laboratory	25	--	25	--	--	50
ECSBL301	Python Laboratory	50	--	50	--	--	100
ECMNP301	Mini Project-1A	50	--	--	--	--	50
HSS301	Product Design	50	--	--	--	--	50
	Total	**350**	**150**	**350**	--	--	**850**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – SY Semester-IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPCC405	Engineering Mathematics-IV	3	--	1	3	--	1	4
ECPCC406	Linear Integrated Circuits	3		--	3	--	--	3
ECPCC407	Principles of Communication	3	--	--	3	--	--	3
ECPCC408	Microcontrollers & Embedded Systems	3	--	--	3	--	--	3
XXMDM402	--	3	--	--	3	--	--	3
ECLBC403	Linear Integrated Circuits Laboratory	--	2	--	--	1	--	1
ECLBC404	Principles of Communication Laboratory	--	2	--	--	1	--	1
ECLBC405	Microcontroller and Embedded System Laboratory	--	2	--	--	1	--	1
ECSBL402	Simulation Laboratory	--	4	--	--	2	--	2
ECMNP402	Mini Project-1B	--	3	--	--	1	--	1
VEC402	Environment and Sustainability	2	--	--	2	--	--	2

Examination Scheme – SY Semester-IV

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECPCC405	Engineering Mathematics-IV	20+25@	30	50	1.5	2	125
ECPCC406	Linear Integrated Circuits	20	30	50	1.5	2	100
ECPCC407	Principles of Communication	20	30	50	1.5	2	100
ECPCC408	Microcontrollers & Embedded Systems	20	30	50	1.5	2	100
XXMDM402	--	20	30	50	1.5	2	100
ECLBC403	Linear Integrated Circuits Laboratory	25	--	25	--	--	50
ECLBC404	Principles of Communication Laboratory	25	--	25	--	--	50
ECLBC405	Microcontroller and Embedded System Laboratory	25	--	25	--	--	50
ECSBL402	Simulation Laboratory	50	--	50	--	--	100
ECMNP402	Mini Project-1B	50	--	50	--	--	100
VEC402	Environment and Sustainability	50	--	--	--	--	50
	Total	**350**	**150**	**425**	--	--	**925**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – TY Semester-V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPCC509	Signals and Systems	3	--	--	3	--	--	3
ECPCC510	Digital Communication	3	--	--	3	--	--	3
XXMDM503	--	3	--	--	3	--	--	3
ECPEC501Y	Program Elective Course-I	3	--	--	3	--	--	3
ECLBC506	HDL Programming Laboratory	--	2	--	--	1	--	1
ECLBC507	Digital Communication Laboratory	--	2	--	--	1	--	1
ECLBC508	Electromagnetics & Antenna Laboratory	--	2	--	--	1	--	1
AEC502	Professional Communication and Ethics-II	1	2	--	1	1	--	2
ECMNP503	Mini Project-2A	--	3	--	--	1	--	1
HSS502	Entrepreneurship	2	--	--	2	--	--	2
	Total	**15**	**11**	**--**	**15**	**5**	**--**	**20**

NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree programs.

List of Courses under Program Elective Course-I (ECPEC501Y)

Course Code	Course Name
ECPEC5011	Electromagnetic Wave Theory
ECPEC5012	Computer Communication Network
ECPEC5013	Digital VLSI[#]
ECPEC5014	Robotics

#: Students who have opted for VLSI as their Honours track, can not opt for Digital VLSI as Program Elective Course-I.

Examination Scheme – TY Semester-V

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid - Sem	End-Sem	
ECPCC509	Signals and Systems	20	30	50	1.5	2	100
ECPCC510	Digital Communication	20	30	50	1.5	2	100
XXMDM503	--	20	30	50	1.5	2	100
ECPEC501Y	Program Elective Course-I	20	30	50	1.5	2	100
ECLBC506	HDL Programming Laboratory	25	--	25	--	--	50
ECLBC507	Digital Communication Laboratory	25	--	25	--	--	50
ECLBC508	Electromagnetics & Antenna Laboratory	25	--	25	--	--	50
AEC502	Professional Communication and Ethics-II	50	--	--	--	--	50
ECMNP503	Mini Project-2A	50	--	--	--	--	50
HSS502	Entrepreneurship	50	--	--	--	--	50
	Total	**305**	**120**	**275**	--	--	**700**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – TY Semester-VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPCC611	Discrete Time signal Processing	3		--	3	--	--	3
XXMDM604	--	4		--	4	--	--	4
ECPEC602Y	Program Elective Course-II	3	--	--	3	--	--	3
ECLBC609	Discrete Time signal Processing Lab	--	2	--	--	1	--	1
ECSBL603	Image Processing and Machine Vision Laboratory	--	4	--	--	2	--	2
XXMDL601	--	--	2	--	--	1	--	1
ECMNP604	Mini Project-2B	--	3	--	--	1	--	1
ELC601	Research Methodology	2	--	--	2	--	--	2
LLC601Y*	Liberal Learning Course	2	--	--	2	--	--	2
	Total	**14**	**11**	**--**	**14**	**5**	**--**	**19**

NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree prorams.

***Liberal Learning Course:**

Every student should take Liberal Learning Course for Semester VI. Students can take this course from the following list of Liberal Learning Courses.

Liberal Learning Courses	
Course Code	**Course Name**
LLC6011	**Art of Living**
LLC6012	**Yoga and Meditation**
LLC6013	**Health and Wellness**
LLC6014	**Diet and Nutrition**
LLC6015	**Personality Development**

List of Courses under Program Elective Course-II (ECPEC602Y)

Course Code	Course Name
ECPEC6021	Random Signal Analysis
ECPEC6022	Optical Fiber Communication
ECPEC6023	Analog VLSI[#]

#: Students who have opted for VLSI as their Honours track, can not opt for Digital VLSI as Program Elective Course-II.

Examination Scheme – TY Semester-VI

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECPCC611	Discrete Time signal Processing	20	30	50	1.5	2	100
XXMDM604	--	20	30	50	1.5	2	100
ECPEC602Y	Program Elective Course-II	20	30	50	1.5	2	100
ECLBC609	Discrete Time signal Processing Lab	25	--	25	--	--	50
ECSBL603	Image Processing and Machine Vision Laboratory	50	--	50	--	--	100
XXMDL601	--	25	--	25	--	--	50
ECMNP604	Mini Project-2B	50	--	50	--	--	100
ELC601	Research Methodology	50	--	--	--	--	50
LLC601Y	Liberal Learning Course	50	--	--	--	--	50
	Total	**310**	**90**	**300**	--	--	**700**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – B. Tech Semester-VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPCC712	Mobile Systems and Wireless Networks	3	--	--	3	--	--	3
ECPEC703Y	Program Elective Course-III	3	--	--	3	--	--	3
ECPEC704Y	Program Elective Course-IV	3	--	--	3	--	--	3
OEC701Y	Open Elective Course –I	3	--	--	3	--	--	3
ECLBC710	High Frequency Laboratory	--	2	--	--	1	--	1
ECLBC711	Wireless Networks Laboratory	--	2	--	--	1	--	1
ECMJP701	Major Project-A	--	6	--	--	2	--	2
HSS703	Financial Planning	2	--	--	2	--	--	2
Total		**14**	**10**	--	**14**	**4**	--	**18**

List of Courses under Program Eelctive Course-III) (ECPEC703Y)

& Program Elective Course-IV (ECPEC704Y)

Course Code	Course Name	Course Code	Course Name
ECPEC7031	Advanced Digital Signal Prossing	**ECPEC7041**	Internet of Things#
ECPEC7032	Microwave Engineering	**ECPEC7042**	Network Security#
ECPEC7033	Computer Architecture in VLSI#	**ECPEC7043**	Deep Learning#

#Students who have opted for Honours in VLSI/ IoT & Embedded Systems/Network Security/AIML, can not opt for respective Program Elective-III or IV in the same domain as Honours.

List of Open Elective Course –I (OEC701Y)

Course Code	Open Elective Course-I
OEC7011	Product Lifecycle Management
OEC7012	Reliability Engineering
OEC7013	Management Information System
OEC7014	Design of Experiments
OEC7015	Operation Research
OEC7016	Cyber Security and Laws@
OEC7017	Disaster Management and Mitigation Measures
OEC7018	Energy Audit and Management
OEC7019	Development Engineering

@Students opting for Honours/Minor degree in Cybersecurity or relevant domain need to select other Open Elective.

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECPCC712	Mobile Systems and Wireless Networks	20	30	50	1.5	2	100
ECPEC703Y	Program Elective Course-III	20	30	50	1.5	2	100
ECPEC704Y	Program Elective Course-IV	20	30	50	1.5	2	100
OEC701Y	Open Elective Course –I	20	30	50	1.5	2	100
ECLBC710	High Frequency Laboratory	25	--	25	--	--	50
ECLBC711	Wireless Networks Laboratory	25	--	25	--	--	50
ECMJP701	Major Project-A	50	--	--	--	--	50
HSS703	Financial Planning	50	--	--	--	--	50
	Total	**230**	**120**	**250**	--	--	**600**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – B. Tech Semester-VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECPEC805Y	Program Elective Course-V	3	--	--	3	--	--	3
OEC802Y	Open Elective Course-II	3	--	--	3	--	--	3
ECMJP802	Major Project-B	--	12	--	--	4	--	4
INT801	Internship~	--	--	--	--	8	--	8
Total		**6**	**12**	**--**	**6**	**12**	**--**	**18**
~ Students have the opportunity to engage in a three-month internship within industry, research organizations, foreign universities, or internal internship for research and product development during the 8th semester, provided they meet the semester requirements and receive approval from the institute.								

NOTE: Please note that due to the internship requirement in the 8th semester, theory courses during this semester will be conducted online either synchronously or asynchronously.

Students can choose program Elective Course-V, from one of the domains listed below. The list of courses within the individual domains will be made available before the course registration

List of Course Domains under Program Elective Course-V (ECPEC805Y)

Course Code	Course Domain
ECPEC8051	Advanced Communication Networks
ECPEC8052	Cloud Technologies
ECPEC8053	Satellite Communication

List of Courses under Open Elective Course-II (OEC802Y)

Course Code	Open Elective Course-II (OEC802Y)
OEC8021	Project Management
OEC8022	Finance Management
OEC8023	Entrepreneurship Development and Management
OEC8024	Human Resource Management
OEC8025	Professional Ethics and CSR
OEC8026	IPR and Patenting
OEC8027	Digital Business Management
OEC8028	Environmental Management

Examination Scheme – B. Tech Semester-VIII

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECPEC805Y	Program Elective Course-V	20	30	50	1.5	2	100
OEC802Y	Open Elective Course-II	20	30	50	1.5	2	100
ECMJP802	Major Project-B	50	--	50	--	--	100
INT801	Internship~	50	--	50	--	--	100
	Total	**140**	**60**	**200**	--	--	**400**

$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for theory, laboratory, and internship courses.

NOTE: Please note that due to the internship requirement in the 8th semester, theory courses during this semester will be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.

D. Multidisciplinary Minor Courses Offered by the Department for the Other Program Students

Curriculum Structure for MDM Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
XXMDMS01Y		3	--	--	3	--	--	3
XXMDMS02Y		3	--	--	3	--	--	3
XXMDMS03Y		3	--	--	3	--	--	3
XXMDLS01Y		--	2	--	--	1	--	1
XXMDMS04Y		4	--	--	4	--	--	4
Total		13	2	--	13	1	--	14

NOTE: The letter 'S' in the above course codes indicate 'Semester' in which that course is offered.

NOTE: To complete the 14-credit requirement for MDM courses, other department student can opt (during semester III to VI)

- Any three theory courses (3-credit each) from ECMDMS—1 to ECMDMS--6
- One theory course (4-credit) from ECMDMS—7 to ECMDMS--8
- One Laboratory course (1-credit) from ECMDLS—1 and ECMDLS—2

from the Basket of courses offered by the EXTC Department as per the table below.

Basket of Theory and Laboratory Courses for MDM Offered by the EXTC Department

Course Code No.	Theory Courses	Course Code No.	Laboratory Courses
ECMDMS--1	Digital Logic And Computer Organization Architecture	ECMDLS--1	Microcontroller and Embedded Laboratory
ECMDMS--2	Digital Logic Design And Analysis	ECMDLS--2	IoT Laboratory
ECMDMS--3	Electronic Components And Circuits		
ECMDMS--4	Microcontrollers		
ECMDMXS--5	Microcontroller And Embedded Systems		
ECMDMS--6	Internet of Things		
ECMDMS--7	Image Processing		
ECMDMS--8	Smart Electronic Systems		

Examination Scheme for MDM Courses

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
XXMDMS01Y		20	30	50	1.5	2	100
XXMDMS02Y		20	30	50	1.5	2	100
XXMDMS03Y		20	30	50	1.5	2	100
XXMDLS01Y		25	--	25	--	--	50
XXMDMS04Y		20	30	50	1.5	2	100
	Total	105	120	225	--	--	450

Examination Scheme for MDM Courses

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECMDMS--1	Digital Logic And Computer Organization Architecture	20	30	50	1.5	2	100
ECMDMS--2	Digital Logic Design And Analysis	20	30	50	1.5	2	100
ECMDMS--3	Electronic Components And Circuits	20	30	50	1.5	2	100
ECMDMS--4	Microcontrollers	20	30	50	1.5	2	100
ECMDMXS--5	Microcontroller And Embedded Systems	20	30	50	1.5	2	100
ECMDMS--6	Internet of Things	20	30	50	1.5	2	100
ECMDMS--7	Image Processing	20	30	50	1.5	2	100
ECMDMS--8	Smart Electronic Systems	20	30	50	1.5	2	100
ECMDLS--1	Microcontroller and Embedded Laboratory	25	--	25	--	--	50
ECMDLS--2	Internet of Things Laboratory	25	--	25	--	--	50

E. Honours, Minor, and Honours in Reseach Degree Program

The Honours, Minor, and Honours in Research degree programs aim to empower students by offering specialized courses/research internships or projects in emerging fields of their interest, thus enhancing their proficiency in those areas. Students who achieve a CGPI of 7.5 or higher by the end of the fourth semester are eligible to pursue an additional 18 credits from the fifth to eighth semesters to qualify for a B. Tech degree with Honours, Minor, or Honours in Research designation. Students need to refer to the Institute level Handbook for Honours/Minor/Honours in Research Degree Programs for further details.

F. First Year Syllabi

Course Type	Course Code	Course Name	Credits
BSC	BSC101	ENGINEERING MATHEMATICS-I	04

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. Differentiation of function of a single variable.
2. Types of matrices and their basic operations.
3. Integration

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO8: Individual and Collaborative Teamwork
4. PO 11: Life-long learning

Course Objectives:	
1.	To provide the basic knowledge of the concepts of Mathematics applicable to the field of engineering.
2.	To build a mathematical foundation of the methodology required for solving application based problems in the field of engineering.

Module	Detailed Contents	Hrs
00.	**Course Introduction** Mathematics is the fundamental step which creates a solid foundation for all Applied fields of Engineering. Professional Engineering applications have Mathematics as an integral part of their evolution. For example: Formulation in Mathematics to various engineering field using case study, Application of matrices in control systems, wireless signals and computer graphics, Introduction to function of several variables to apply in Marginal rate of technical substitution and Elasticity of substitution. Hence, Formulation Based Mathematics is a fundamental requisite to all fields of Engineering for analyzing their performances.	01

01.	**Matrices - I** ***Learning Objective:*** • *Analysis and interpretation of the basic fundamentals of matrices.* • *Determination of the rank of a matrix by applying the concepts of elementary transformation of a matrix.*	**06-08**
	Contents: Introduction of Matrices through a discussion on the need to study matrices as they are essential tools for solving systems of equations, analyzing electrical circuits, performing structural analysis, and modeling complex systems in various engineering fields. Type of Matrices and Properties, Symmetric, Skew-Symmetric, Orthogonal Matrices, Complex Matrix, Hermitian, skew-Hermitian, Unitary Matrices, Rank of a Matrix, Elementary transformation, Normal Form, Echelon Form.	
	Self-Learning Topics: *Learning Outcomes:* ***A learner will be able to*** ***LO 1.1:*** *Apply algebraic techniques to identify and classify different types of matrices, including symmetric, skew-symmetric, orthogonal, Hermitian, Skew-Hermitian, and unitary matrices. (P I 1.1.1, PI 11.1.3)* ***LO 1.2:*** *Identify the structural properties of complex and real matrices by verifying conditions for symmetry, orthogonality, and unitarily***.** *(P I 2.1.3)* ***LO 1.3****: Identify the process of reducing a matrix to its Normal Form using elementary transformations to determine its rank. (PI 2.2.3)* ***LO 1.4:*** *Apply the properties of special matrices (e.g., orthogonal or Hermitian) to solve problems in engineering contexts such as signal processing or structural analysis. (P I 1.2.1)* ***LO 1.5:*** *Articulate the importance of staying updated with current matrix-based computational tools and methods, highlighting how this continuous learning fosters lifelong learning and enhances problem-solving skills in professional engineering practice. (PI 2.1.1, P I 11.2.1)*	
02.	**Matrices – II** ***Learning Objective:*** • *Analysis of the differences between homogeneous and non-homogeneous simultaneous equations* • *Application of these concepts to find their solutions, if they exist.*	**11-13**
	Contents: Solution of system of Linear Equations, Condition for consistency of Non-Homogeneous Equations, Condition for consistency of Homogeneous Equations, Row Vector and Column Vector, Linearly dependence and Independence of vectors, Linear Combination of Vectors.	

	Self-Learning Topics: Coding Theory ***Learning Outcomes:*** *A learner will be able to* *LO.2.1: Identify using relevant mathematical knowledge if the system of homogeneous / non-homogeneous linear equation is consistent and determine its type of solution (P I 2.1.3)* *LO.2.2: Identify the most appropriate method for solving a given system of linear equations and state if the system has one solution, no solution, or infinite solutions. (P I 2.2.3)* *LO 2.3: Identify the algebraic technique to solve a given system of equation. (P I 1.1.1)* *LO 2.4 Identify using relevant mathematical knowledge whether a set of vectors is linearly dependent or independent. (P I 2.1.3)* *LO 2.5: Identify relevant process to express a vector as a linear combination of other vectors by applying basic laws of mathematics (P I 1.2.1,)* *LO 2.6: Communicate clearly with team members while working as a team analyzing a problem on linearly dependent or independent vectors and resolve differences in approach during group work by listening and finding common solutions. (P I 8.2.1)* *LO 2.7: Collaboratively solve problems on linear combinations and linearly dependent / independent vectors using appropriate methods and present it with precision. (PI 8.3.1)*	
03.	**Matrices – III** ***Learning Objective:*** • *Analysis and computation of Eigen Values and Eigen Vectors.* • *Enumeration and application of the concept of Eigen value and Eigen vector to Engineering Models.* • *Application of the concepts of Eigen values and Eigen Vectors for finding the function of matrix using Cayley-Hamilton Theorem.*	**12-14**
	Contents: Introduction to Eigen Values, Characteristic equation, Characteristic roots & Eigen vectors. Finding Eigen values and Eigen vectors for different types of Matrices: Non Symmetric Matrices with non-repeated Eigen Values, Non Symmetric Matrices with Repeated Eigen Values, Symmetric Matrices with non-repeated Eigen Values, Symmetric Matrices with Repeated Eigen Values Cayley-Hamilton Theorem (Without proof), Statement and verification,	
	Self-Learning Topics: *Function of square matrix as an application of Eigen values and Eigen vectors.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1 Identify mathematical knowledge to form the characteristic equation of a square matrix to find its eigenvalues using basic algebraic operations. (P I 1.1.1)* *LO 3.2: Identify relevant solution method to calculate eigenvalues and eigenvectors for a given matrix. (P I 2.2.3)*	

	LO 3.3: Compare methods for finding eigenvalues of different matrix types and choose the most suitable one. (P I 2.2.4) *LO 3.4: Identify the appropriate method to determine Eigen vectors for corresponding Eigen values. (PI-2.1.3)* *LO 3.5: Identify the need to apply appropriate mathematical concept to verify the Cayley-Hamilton theorem for a given square matrix (P I 2.1.3, PI 11.1.3)* *LO 3.6: Apply the Cayley-Hamilton theorem effectively to express matrix functions by using basic laws of mathematics. (P I 1.2.1)*	
04.	**Differential Calculus of Several Variables-I** ***Learning Objectives:*** • *Analysis of the fundamentals of differentiations of functions of two or more independent variables* • *Application of this concept to determine differentiation of function of functions, composite functions and implicit functions.* **Contents:** Introduction to Partial differentiation through a discussion on how it is important for engineering students. As it helps analyze how systems change with respect to multiple variables, which is essential in fields like thermodynamics, fluid mechanics, and structural analysis. Introduction to Partial Differentiation, Geometrical meaning of Partial derivatives of first and higher order, Differentiation of function of function, Differentiation of composite function. ***Self-Learning Topics:*** *Jacobian of two and Three variable* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Identify the basic concepts of partial differentiation (PD) with the prerequisite of differentiation of function of a single variable and apply suitable procedure to partially differentiate a function of several variables. (PI-2.2.3)* *LO 4.2: Apply the chain rule to differentiate a function of a function involving partial derivatives. (P I 1.1.1)* *LO 4.3: Apply the relevant concept to differentiate composite functions involving multiple variables and parameters using fundamentals laws of mathematics. (P I 1.2.1)* *LO 4.4: Compare direct and indirect methods of partial differentiation and select the most efficient one to solve a given problem. (P I 2.2.4, PI.11.1.3)* *LO 4.5: Analyze and state the need of how staying updated with current Partial Differentiation-based computational tools and methods contributes to lifelong learning and enhances problem-solving skills in professional engineering practice. (P I 11.2.1)*	**05-07**

05.	**Differential Calculus of Several Variables-II** ***Learning Objective/s:*** • *Application of the concept of PD to solve problems by using Euler 's Theorem on Homogeneous functions with two independent variables.* • *Analysis of the learned concept of PD and apply it to find maxima and minima of functions of two variables*	
	Contents: Homogeneous functions, Euler's Theorem on Homogeneous functions with two Independent variables(With Proof) , Deductions from Euler's Theorem, Maxima and Minima of a function of two independent variables.	
	Self-Learning Topics: *Euler's Theorem on Homogeneous functions with three Independent variables* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1*: *Identify when Euler's Theorem is applicable in a given partial differentiation problem. (P I 2.1.3)* *LO 5.2: Identify the relevant method (Euler's Theorem) to solve a problem of homogeneous function in partial differentiation. (P I 2.2.3)* *LO 5.3: Identify the deductions derived from Euler's Theorem which should be used effectively to solve a given problem. (P I 2.1.3)* *LO 5.4: Apply the method to find the maxima and minima of functions of two variables using the laws of partial derivatives (P I 1.2.1)* *LO 5.5: Identify the existing method of second derivative tests to determine whether a critical point is a maximum, minimum, or saddle point. (P I 2.2.3)* *LO 5.6: Apply the solution method of maxima & minima to solve a real-world optimization problem. in a collaborative work as a team. (P I 1.1.1, P I 8.2.1)* *LO 5.7: Formulate clear problem statements for optimization tasks involving functions of two variables and Present the final solution as a cohesive team, integrating individual findings into a unified explanation. (P I 2.1.1, P I 8.3.1)*	**07-09**
06.	**Beta and Gamma Functions** *Learning Objective:* • ***Analysis and interpretation of the basic definition of Beta and Gamma Functions and their properties.*** • ***Application of the definition and properties of Beta and Gamma Functions to solve definite integrals.***	**11-14**
	Contents: Definitions, Gamma Function, Beta Function, Properties of Beta and Gamma Function, Relationship between Beta and Gamma Function, Duplication Formula.	

	Self-Learning Topic: ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Identify the relevant process to e**valuate** Beta functions and Gamma functions for positive real numbers using standard formulas. (P I 2.2.3)* *LO 6.2: Apply the basic definition of beta and gamma function to solve the definite integral. (P.I.1.1.1)* *LO 6.3: Apply properties of Gamma and Beta functions to solve a definite integral problem by identifying the relevant concept. (P I 1.2.1)* *LO 6.4: Compare between duplication formula and relation between Beta and gamma functions to be used to solve a given definite integral problem and solve it. (P I 2.2.4)*	
	Course Conclusion	**01**
Total		**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques as calculus/algebra to solve problems.
1.2.1	Apply laws of natural science to a Mathematical problem.
2.1.1	Articulate problem statements and identify objectives.
2.1.3	Identify the mathematical knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the Problems.
2.2.4	Compare and contrast alternative solution processes to select the best process.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.3.1	Present result as a team, with smooth integration of contributions from all individual efforts.
11.1.3	Identify various mathematical concepts/theorems which can be utilized in the field of application based engineering
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

Course Outcomes:
A learner will be able to

1. Apply the concept of rank of a matrix to find the solution of homogeneous and non-homogeneous system of equations by analysing their consistency. *(LO 1.1, LO1.2, LO1.3, LO1.4, LO 1.5, LO 2.1, LO2.2, LO2.3, LO2.4, LO 2.5, LO 2.6, LO 2.7)*

2. Analyse the characteristic equation to determine the Eigen value, Eigen vector, also function of a matrix by applying Cayley-Hamilton theorem. (*LO 3.1, LO3.2, LO3.3, LO3.4, LO 3.5, LO 3.6)*
3. Implement the fundamentals of partial differentiation to evaluate the maxima and minima of functions of several variables. *(LO 4.1, LO4.2, LO4.3, LO4.4, LO 4.5, LO 5.1, LO5.2, LO5.3, LO5.4, LO 5.5, LO 5.6, LO 5.7)*

4. Implement the fundamentals of Beta and Gamma Function to evaluate the definite integral. (*LO 6.1, LO6.2, LO6.3, LO6.4)*

5. Analyse and apply all mathematical tools acquired through the course and exhibit the knowledge through written solutions through team and individual activities. *(LO 1.1, LO1.2, LO1.3, LO1.4, LO 1.5, LO 2.1, LO2.2, LO2.3, LO2.4, LO 2.5, LO 2.6, LO 2.7, LO 3.1, LO3.2, LO3.3, LO3.4, LO 3.5, LO 3.6, LO 4.1, LO4.2, LO4.3, LO4.4, LO 4.5, LO 5.1, LO5.2, LO5.3, LO5.4, LO 5.5, LO 5.6, LO 5.7, LO 6.1, LO6.2, LO6.3, LO6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC101.1	3	3						3			3
BSC101.2	3	3									
BSC101.3	3	3						3			3
BSC101.4	3	3									
BSC101.5	3	3						3			3
Average	3	3						3			3

Text Books :

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, forty fourth Edition, 2021
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, Tenth Edition, 2011.
3. Advanced Engineering Mathematics, H.K.Das, S. Chand and Company Limited, Fourth Edition, 2018.

Reference Books:

1. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press, First Edition, 2015
2. Engineering Mathematics by P. Sivaramakrishna Das and C. Vijayakumari, Pearson, First Edition, 2017

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

a) One MCQ Test + One Class Test: 05+05 = 10 Marks

b) One Team Pair Solo (TPS) activity: 05 Marks

c) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
BSC	BSC102	Engineering Physics-I	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World

Course Objectives:

1. To provide the Basic knowledge on the concepts of physics pertaining to the field of engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of physics in the field of engineering

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Interference in Thin Film and Diffraction** ***Learning Objective:*** *•To study the basic concept of interference and diffraction phenomena in various measurements* *•To recognize the principles of interference and diffraction to solve practical problems.*	**6-8**
	Contents: Interference: Interference by division of amplitude; Interference in thin film of constant thickness: Application in Anti-reflecting films. Wedge shaped film: Newton's rings - Diameters of dark Newton's rings; Applications in determination of refractive index of liquid. Diffraction: Diffraction Grating, Diffraction due to grating; Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating.	
	Self-Learning Topics: *Origin of colours in thin film, Diameters of Bright Newton's rings, Determination of radius of curvature of the lens and wavelength of incident light using Newton's rings experiment.*	

	Learning Outcomes: *A learner will be able to* *LO 1.1: apply the concept of thin film interference and diffraction to determine various parameters of real life problems. (P.I.- 1.2.1)* *LO 1.2: apply the concepts of thin film interference and diffraction to solve problems. (P.I.- 1.3.1)* *LO 1.3: identify the parameters which affect the quality of optical components. (P.I.- 2.1.2)* *LO 1.4 identify the mathematical process and knowledge of interference to derive the conditions of maxima and minima for thin film interference. (P.I.- 2.1.3)*	
02.	**LASER** ***Learning Objective:*** • *To provide the knowledge of absorption and emission in production of laser.* • *To explore the use of lasers in technical fields and associate the impact of laser applications in environment and societal context.*	**3-5**
	Contents: Laser: Stimulated emission and multiplication process; Population inversion; Pumping; Metastable state: Resonant cavity; Helium Neon laser: construction and working; Nd:YAG laser: construction and working; Industrial and medical applications of LASER.	
	Self-Learning Topics: *Absorption, Spontaneous emission, Advantages, disadvantages of He-Ne and Nd:YAG laser.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: apply the knowledge of transitions of atoms within the material in the context of LASER production. (P.I.-1.2.1)* *LO 2.2: identify various parameters which affect LASER emission. (P.I.-2.1.2)* *LO2.3: Identify components and medium to produce LASER of different wavelengths. (P.I-.2.2.3)* *LO 2.4: identify the impact of using LASER in industrial and medical fields.* *(P.I.-6.1.2)*	
03.	***Fiber Optics*** ***Learning Objective:*** *•To build the knowledge of optical phenomena in optical fibre and analyze the role of optical fibre in fibre optics communication* *•To study the principle of fibre optics to solve engineering problem.*	**3-5**
	Contents: Optical Fibre; Numerical aperture; Angle of acceptance; V-number; Types of optical fibres; Numerical aperture for step index fibre; Fibre optic communication system.	

	Self-Learning Topics: *Critical angle, Fractional index change, Modes of propagation.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: apply the knowledge of optical phenomena in propagation of light through optical fibre. (P.I.-1.2.1)* *LO 3.2: identify various parameters required for the fabrication of optical fibre. (P.I.- 2.1.2)* *LO 3.3: apply the concepts of fibre optics to solve problems (P.I.- 1.3.1)* *LO3.4: identify various parameters to differentiate types of optical fibre. (P.I.- 2.1.2)* *LO 3.5: identify the mathematical process and knowledge of optical phenomena to determine numerical aperture and acceptance angle of an optical fibre (P.I.-2.1.3)* *LO 3.6: identify the importance of fibre optic communication system to meet public need. (P.I.- 6.1.1)*	
04.	***Semiconductor Physics*** ***Learning Objectives:*** *•To provide the fundamental knowledge of band gap in semiconductors* *•To familiarize the concept of fermi level in semiconductor for solving problems.*	**4-6**
	Contents: Energy bands in semiconductor; Direct & indirect band gap semiconductor; Determination of energy band gap in semiconductor. Fermi level; Fermi Dirac distribution, Fermi level in intrinsic semiconductors, Fermi level in extrinsic semiconductors: Effect of temperature and impurity concentration on fermi level in extrinsic semiconductors, Significance of Fermi level.	
	Self-Learning Topics: *Effect of temperature on fermi level in P-type semiconductor, Effect of impurity concentration on fermi level in N-type semiconductors.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: apply the knowledge of energy bands and Fermi levels to interpret semiconductors. (P.I.-1.2.1)* *LO 4.2: apply the knowledge of fermi level to solve the problems (P.I.-1.3.1)* *LO 4.3: identify various parameters to compare direct and indirect semiconductors. (P.I.-2.1.2)* *LO 4.4: identify the method to analyze the effect of temperature and impurities on fermi level in extrinsic semiconductor. (P.I.-2.2.3)*	
05.	**Semiconductor Devices** ***Learning Objective/s:*** *•To gain the fundamental knowledge of semiconductor in various semiconductor devices.* *•To recognize the impact of semiconductor devices in different societal issues.*	**3-5**

	Contents: Semiconductor Devices: Hall sensor: Principle, construction, working and application; Semiconductor laser: Principle, construction, working and application; Solar cell: Principle, construction, working, application and its importance in society.	
	Self-Learning Topics: *Light Emitting Diode (LED), Photodiode.*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: apply physics of semiconductors in semiconductor devices. (P.I.-1.2.1)* *LO 5.2: identify physical phenomena in semiconductors, components and process for making various semiconductor devices (P.I.-2.1.2)* *LO5.3: identify the applications of semiconductor laser and solar cell to meet the public need. (P.I.- 6.1.1)*	
06.	**Superconductors** ***Learning Objective/s:*** *•To summarize the properties and applications of superconductors.* *•To familiarize the concept of superconductors to evaluate problems.*	**3-5**
	Contents: Superconductivity, critical temperature, critical magnetic field, Meissner effect; Type I and Type II superconductors; Applications of superconductor in MAGLEV.	
	Self-Learning Topics: *High temperature superconductor and its importance.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: apply the knowledge of various parameters required to study superconductor. (P.I.-1.2.1)* *LO 6.2: apply the concepts of superconductor to solve problems (P.I.-1.3.1)* *LO 6.3: identify various parameters to differentiate the type of superconductors (P.I.-2.1.2)* *LO 6.4: identify the application of superconductors in MAGLEV train for public transportation. (P.I.- 6.1.1)* *LO 6.5: identify the impact of temperature in superconductor. (P.I.-6.1.2)*	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
1.2.1	Apply laws of physics to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
6.1.1	Identify and describe various role of science particularly as pertains to protection of the public and public interest at global, regional and local level.
6.1.2	Identify risks/impact in the life-cycle of an engineering product or activity.

Course Outcomes:

A learner will be able to -

1. apply the fundamental knowledge of optical phenomena to analyse the relevant problems and draw the conclusions. (*LO 1.1, LO 1.2, LO 1.3, LO 1.4*)
2. apply the knowledge of Laser, fiber optics for societal issues by analysing the process of fabrication, their properties and various parameters. (*LO 2.1, LO2.2, LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6*)
3. apply the fundamental knowledge of semiconductor physics to identify and analyse the various parameters to solve the problem. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4*)
4. identify the role and impact of the semiconductor devices and superconductors by knowing their process of fabrication and applications. (*LO 5.1, LO5.2, LO 5.3, LO 6.1, LO 6.2, LO 6.3,6.4,LO6.5*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC102.1	3	3									
BSC102.2	3	3				3					
BSC102.3	3	3									
BSC102.4	3	3				3					
Average	3	3				3					

Text Books :

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

Reference Books :

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Optics, Ajoy Ghatak, Seventh Edition, 2020, Tata McGraw Hill

   Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley

4. A textbook of Optics - N. Subramanyam, Brijlal and Avadhanulu, 23rd Edition, 2006, S.Chand Publishing.

Other Resources :

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web link- www.physics.rutgers.edu
3. NPTEL Course: Fundamentals of semiconductor devices, by Prof. Digbijoy N. Nath, IISc Bangalore:- Web link- https://nptel.ac.in/courses/108108122

A. IN-SEMESTER ASSESSMENT (35 MARKS)

1. Continuous Assessment - Theory-(15 Marks)

a) MCQ test: 4 marks
b) Class test: 4 marks
c) Open book test/Open notes test: 4 marks
d) Regularity and active participation: 3 marks

2. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (40 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
BSC	BSC103	ENGINEERING CHEMISTRY- I	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Pre-requisite:

1. Nil

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6 -The engineer and the world

Course Objectives:

1. To enable the students to apply the laws of chemistry to an engineering problem.
2. To enable the students to study material properties and their engineering applications.
3. To enable the students to analyse and select the most appropriate engineering material
4. To study the current developments in the field of nanotechnology, energy storage systems and green chemistry for sustainable development.

Module	Details	Hrs.
00.	**Course Introduction** Engineering chemistry provides the fundamental understanding of materials, substances and processes that engineers need to design, develop and manufacture products and systems.	01
01.	**Green Chemistry** ***Learning Objective:*** *To state the principles of green chemistry and apply them in the synthesis of various industrially important chemical substances and drugs in order to exhibit the social and environmental impact of chemical industry practices for the sustainable design and development.*	4-6
	Contents: Introduction, 12 principles of green chemistry with examples as Conventional and green synthesis of carbaryl, adipic acid, benzimidazole and Indigo with special emphasis on bioenzymes and catalyst. Numericals on atom economy. Carbon Sequestering and Carbon Credit. Green solvents:- water as green solvent, supercritical solvents and	

	DMC.	
	Self-Learning Topics: *12 principles of green chemistry, latest research areas in the field of green chemistry.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify the hazards involved in traditional synthesis of carbaryl, adipic acid, benzimidazole and indigo for improving their benign nature. (2.2.3)* *LO 1.2: -Apply the principles of green chemistry for developing the safe green reactions in chemical industries. (1.3.1)* *LO 1.3: Identify and analyze the case of chemical disaster in industry. (2.1.3)* *LO 1.4: Identify the appropriate green solvents to be used in chemical processes to assess the public health and safety. (6.1.1)* *LO 1.5: Analyse the concepts of Carbon Sequestering and Carbon Credit for their impact on environmental sustainability. (6.1.2)* *LO 1.6: Apply the formula of atom economy to solve the numerical problems. (1.2.2)*	
02.	**Water quality management**	**4-6**
	Learning Objective: • *To classify water hardness into various types, state their causes and effects on industrial processes and use the modern methods of water treatment to improve the quality of water.* • *To state the impact of water pollution in order to practice the sustainable water quality management.*	
	Self-Learning Topics: *Basic stoichiometry, mole concept, expression of concentration via normality, molarity, writing molecular formulae and calculation of molecular weights of common salts of heavy metal ions.*	
	Contents: Quality of industrial water - Boiler troubles (Scale and Sludge, Boiler Corrosion, Caustic Embrittlement) Hardness and its types and numericals. Membrane filtration technology: - Ion exchange and reverse osmosis. Numericals based on ion exchange method. Water pollution: - Water quality indices- BOD and COD with numericals. Quality of drinking water – disinfection by chlorination and ozone treatment.	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Analyze the given sample of water for various types of hardness. (2.1.3)* *LO 2.2: Identify the chemical methods to solve the boiler problems. (2.2.3)* *LO 2.3: Identify various industrial and municipal water treatments for assessing the public health (6.1.1)* *LO 2.4 Apply the knowledge of fundamental chemistry to solve the numerical problems based on hardness, ion exchange method and water quality indices. (1.2.2)* *LO 2.5: Analyse the different water quality indices for controlling the pollution of water. (6.1.2)* *LO 2.6: - Apply the knowledge of membrane filtration technology to improve the*	

	quality of drinking water. (1.3.1)	
03.	**Science of Corrosion**	**4-6**
	Learning Objective: *To state the mechanisms of different types of corrosion and suggest the corrosion control methods for the same in Industry.*	
	Contents: Introduction to corrosion, mechanism of dry corrosion – Oxidation corrosion, Pilling Bedworth rule and wet Corrosion-Mechanisms of wet corrosion, Types of wet corrosion (galvanic, differential aeration, stress and Intergranular corrosion). Methods of prevention of Corrosion- cathodic protection (Sacrificial, impressed current) Protective coatings- Metallic coatings (tinning and galvanizing).	
	Self-Learning Topics: *Factors affecting rate of corrosion-size of electrodes, passivity, position of metal in galvanic series and polarization.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify the different types of corrosion to analyse the state of metals and alloys in engineering equipment. (2.1.3)* *LO 3.2: Apply the mechanism of oxidation corrosion for protecting the metals and alloys against dry corrosion. (1.3.1)* *LO 3.3: Apply the Pilling Bedworth rule to assess the nature of oxide layers (1.2.1)* *LO 3.4: Identify the mechanisms and conditions of different types of wet corrosion to analyse the state of metals and alloys. (2.1.3)* *LO 3.5: Apply the cathodic protection methods for improving the safety of metallic equipment and structures. (1.3.1)* *LO 3.6: Apply metallic coatings such as tinning and galvanizing to enhance corrosion resistance for protection of public health. (6.1.1)*	
04.	**Introduction to Thermodynamics**	**4-6**
	Learning Objectives: *To state the fundamentals of thermodynamics and apply them in engineering.*	
	Contents: Concepts of system, types of systems, surroundings. Extensive and intensive properties, Macroscopic and microscopic approach, heat and work, Thermodynamic equilibrium, reversible and irreversible process, relation between pressure-volume and work, First law of thermodynamics – internal energy and enthalpy. Applications of thermodynamics in engineering, numericals	
	Self-Learning Topics: *Nil*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the knowledge of classification of systems to solve the real life problems. (1.3.1)* *LO 4.2: Apply the first law of thermodynamics to different types of systems. (1.2.1)*	

	LO 4.3: Apply the formulae based on work, heat, internal energy, and enthalpy in various thermodynamic systems for solving the numerical problems. (1.2.2) *LO 4.5: Identify the concepts of thermodynamics for analyzing engineering devices. (2.1.3)*	
05.	**Phase Equilibria** ***Learning Objective/s:*** *To interpret the various phase transformations using thermodynamics.* **Contents:** Gibb's Phase Rule, Terms involved with examples, One Component System (Water) and its applications, reduced Phase Rule, Two Component System (Pb- Ag), and Eutectic system: Applications in solder alloys, limitations of phase rule and numericals. ***Self-Learning Topics:*** *Basic thermodynamics-concept of chemical system, equilibrium, Gibb's free energy, variable factor affecting the equilibrium of chemical systems.* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Apply Gibb's phase rule and reduced phase rule to the given system. (1.2.1)* *LO 5.2: Apply the phase rules to one and two component systems to determine the degrees of freedom at different phases at phase diagrams. (1.3.1)* *LO 5.3: Apply the phase rule equations and concept of eutectic for solving the numerical problems. (1.2.2)* *LO 5.4: Identify the concept of eutectic system for improving the operation of safety devices. (2.2.3)*	**3-5**
06.	**Energy from non-conventional sources** ***Learning Objective/s:*** *To apply the knowledge of synthesis of non-conventional chemical fuels and deal with the challenges involved in their implementation with respect to sustainable development.* **Contents:** Synthesis and applications of Biodiesel, Hydrogen production by steam reforming of methane and electrolysis of water, challenges in hydrogen storage and transport. ***Self-Learning Topics:*** *Knowledge of conventional fuels and their types, problems associated with their use and need for renewable energy sources.* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply the transesterification reaction for the production of biodiesel (1.3.1)* *LO 6.2: Analyse environmental aspects of biodiesel and electrolysis of water as green fuels for their impact on sustainability. (6.1.2)* *LO 6.3: Identify the environmental problems in the process of steam reforming of methane for analyzing the quality of hydrogen. (2.1.3)* *LO 6.4: Identify the challenges in hydrogen production, storage and transport for assessing the public safety. (6.1.1)*	

	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem.
1.2.2	Apply the formulae based on the concepts of engineering chemistry for solving the numerical problems.(New PI)
1.3.1	Apply fundamental engineering chemistry concepts to solve engineering problems.
2.1.3	Identify the engineering chemistry concepts to analyse the given problem
2.2.3	Identify the existing processes/ solution methods for solving the problems.(Modified PI)
6.1.1	Identify and describe the various roles of materials particularly as pertains to protection of the public and public interest at global, regional and local level.
6.1.2	Analyse the environmental aspects of engineering materials or activities for their impact on sustainability.(Modified)
6.2.1	To identify and interpret standard guidelines for the safety and efficiency of chemical industries.

Course Outcomes: A learner will be able to -

1. Apply the laws of electrochemistry and thermodynamics for solving engineering problems. *(LO-3.1, LO-3.2, LO-3.3, LO-3.4,LO-3.5,LO-3.6, LO-4.1, LO-4.1, LO-4.2, LO-4.3, LO-4.4, LO- 5.1, LO- 5.2, LO- 5.3, LO- 5.4, LO- 6.1, LO- 6.2, LO- 6.3, LO- 6.4)*
2. Analyse the quality of water and challenges in non-conventional energy sources for solving the real-world problems *(LO-1.1, LO- 1.2, LO-1.3, LO-1.4, LO- 1.5, LO-1.6, LO- 2.1, LO-2.2, LO- 2.3, LO- 2.4, LO- 2.5, LO- 2.6, LO- 6.1, LO- 6.2, LO- 6.3, LO- 6.4)*
3. Identify the suitable chemical product or material for the protection of environment and public health. *(LO-1.1, LO- 1.2, LO-1.3,LO-1.4,LO-1.5,LO-1.6, LO- 2.1, LO- 2.2, LO-2.3,LO-2.4,LO-2.5,LO-2.6,LO- 2.7, LO-3.1, LO-3.2, LO-3.3, LO-3.4, LO-3.5,LO-3.6, LO-3.7, LO-3.8, LO-3.9, LO- 6.1, LO- 6.2, LO- 6.3, LO- 6.4)*
4. Interpret the impact of modern chemical industrial practices and energy sources for sustainable development. *(LO-1.1, LO- 1.2, LO-1.3, LO-1.4, LO-1.5, LO-1.6, LO- 2.1, LO-2.2, LO- 2.3, LO- 2.4, LO- 2.5, LO- 2.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC103.1	3	3	-	-	-	3	-	-	-	-	-
BSC103.2	3	3	-	-	-	3	-	-	-	-	-
BSC103.3	3	3	-	-	-	3	-	-	-	-	-
BSC103.4	3	3	-	-	-	3	-	-	-	-	-
Average	**3**	**3**	-	-	-	**3**	-	-	-	-	-

Text Books :

1. A textbook of engineering chemistry by S. Dara, 2014 edition, Chand Publication.
2. A Textbook of chemistry by Shashi Chawla, First edition, 2019, Dhanpatrai and Co.
3. Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

Reference Books :

1. Engineering Chemistry by Jain and Jain, 17th edition, 2018, Dhanpatrai Publications.
2. Engineering Chemistry by Raghupati Mukhopadhyay, First edition, 2007, New Age International Publisher
3. Engineering Chemistry by Payal Joshi and Shashank Deep, First edition, 2019, Oxford

Other Resources :

1. Online chemistry library for open access text books: https://chem.libretexts.org

A. IN-SEMESTER ASSESSMENT (35 MARKS)

1. Continuous Assessment - Theory-(15 Marks)

1. Numerical Assignment/s (min 20 problems):4 Marks
2. Class test based on numerical assignment: 4 Marks
3. Article reading & summarization: 4 Marks
4. Regularity and active participation: 3 Marks

2. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (40 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
ESC	ESC101	ENGINEERING MECHANICS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO8: Individual and Collaborative Team work
4. PO9: Communication

Course Objectives:

1. To familiarize with the concepts of force, moment, Resultant and Equilibrium of system of coplanar force.
2. To acquaint with the basic concept of friction and its application in real-life problems.
3. To recognize the parameters required to quantify the Kinematics of Particle and Rigid body.
4. To introduce the parameters required to quantify the Kinetics of rigid body.
5. To acquaint with basic principles of centroid and its application

Module	**Details**	Hrs.
	Course Introduction The Engineering Mechanics Course marks the transition from physics to engineering applications. This course develops the ability to apply and analyze, which are paramount in engineering profession.	**01**
01.	***Coplanar force System: System of Coplanar Forces*** ***Learning Objective:*** *To impart the knowledge of fundamental concepts of Mathematics and Physics to analyze forces in engineering system.*	**06-09**
	Contents: Classification of force systems (Concurrent, Parallel and General Force systems). Principle of Transmissibility, Composition and Resolution of Forces. Resultant of Coplanar Force Systems: Resultant of coplanar force system (Concurrent, Parallel and non- concurrent non-parallel force systems). Moment of force about a point, Couples, Varignon's Theorem and its significance. Force couple system.	
	Self-Learning Topics: Application of Varignon's Theorem	

	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts for resolution of system of forces. (P.I.-1.3.1)* *LO 1.2: Apply mechanical engineering concepts to find resultant forces acting in a system under the action of load. (PI-1.4.1)* *LO 1.3: Identify unknown forces in engineering systems due to application of load. (PI-2.1.2)* *LO 1.4: Identify the relevant mathematical, physical, and engineering principles required to determine the magnitude, direction, and line of action of the resultant force acting on a structural member. (P.I.-2.1.3).*	
02.	**Equilibrium of Rigid Bodies in Statics. Equilibrium of Coplanar Force System:** ***Learning Objective:*** *To use fundamental concepts of engineering knowledge of equilibrium and to analyze reactions under the influence different types of loading conditions.* **Contents:** Conditions of equilibrium for Concurrent, Parallel and General Force System (Non-Concurrent Non- Parallel forces) and Couples. Application of Equilibrium Concepts on rigid bodies in Equilibrium. **Equilibrium of Beams:** Different Types of Supports and Loading. Determination of reactions at supports for various types of loads including distributed system on beams. (Excluding problems on internal hinges). **Friction:** Concepts of Angle of Friction, Angle of Repose, Cone of Friction. Equilibrium of bodies kept on inclined plane. Application of Friction Concepts to problems involving ladders and the tipping over of bodies. ***Self-Learning Topics:*** *Beam Reaction under Combined Loads* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply fundamental mathematical knowledge for application of equilibrium concepts on rigid bodies(P.I.-1.1.2)* *LO 2.2: Apply mechanical concepts to coplanar force systems and calculate reactions in beams(P.I.-1.4.1)* *LO 2.3: Identify the key system variables and parameters such as coefficient of friction, normal reaction, and angle of repose required to analyze equilibrium of a rigid body under frictional forces. (P.I.-2.1.2)* *LO 2.4: Formulate mathematical models by applying scientific principles and engineering concepts to represent force and friction interactions in beams, inclined planes, and ladder problems. (P.I.-2.3.1)* *LO2.5: Implement agreed team roles, agendas, and communication norms to collaboratively solve equilibrium and friction problems on inclined planes and ladders. (P.I. – 8.1.2)* *LO2.6: Demonstrate leadership and conflict-resolution skills by guiding your team to agree on assumptions and methods when calculating support reactions in beam equilibrium problems. (P.I. – 8.2.1)* *LO 2.7: Prepare a report on equilibrium of beams, inclined planes, and ladders, using*	**06-08**

	clear diagrams, step-by-step calculations, and concise technical language. (P.I. – 9.1.2) *LO 2.8: Present your analysis of support reactions and friction on inclined planes and ladders using clear engineering language, and respond effectively to peer questions. (P.I. – 9.2.1)*	
03.	**Kinematics of Particle** ***Learning Objective:*** *Learner will be able to understand kinematics, including variable acceleration, motion curves, curvilinear motion, and projectile motion, applying concepts to real-life situations through problem-solving.* **Contents:** Motion of particle with Variable Acceleration. Motion Curves (a-t, v- t, s-t curves). General Curvilinear Motion. Tangential and Normal Component of Acceleration. Projectile Motion: Trajectory Equation of Projectile. Application of the concepts of Projectile Motion in real life and related numerical. ***Self-Learning Topics:*** *Projectile Motion Basics, Variable acceleration concept* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply knowledge to identify the motion of the object using the equations of motion (P.I.- 1.2.1).* *LO 3.2: Apply the fundamental mathematics and mechanical engineering concepts to examine different types of motions (P.I.-1.4.1).* *LO 3.3: Identify system variables to formulate trajectory equation of projectile motion (P.I.2.1.2).* *LO 3.4: Identify the mathematical relationships, physical laws, and key parameters (e.g., initial velocity, angle of projection, acceleration due to gravity) required to model and predict the motion of a particle in real-life scenarios. (P.I.-2.1.3).*	**07-09**
04.	**Kinematics of Rigid Body** ***Learning Objectives:*** *To understand the parameters required to quantify the Kinematics of Particle and Rigid body.* **Contents:** Rigid Body Motions: Translation, Rotation and General Plane motion. Kinematics of Rotation and related numerical. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR for 2 link mechanism. Velocity analysis of rigid body using ICR. ***Self-Learning Topics:*** *Sine and Cosine Rule* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Apply engineering knowledge to identify the general plane motion(P.I.-1.3.1).* *LO 4.2: Apply mathematical knowledge to find translational, rotational and general plane motion of rigid bodies(P.I.-1.4.1).* *LO 4.3: Identify engineering systems and variables to find instantaneous center of rotation*	**06-08**

	for link mechanism (P.I-2.2.1). *LO 4.4: Identify the mathematical models, kinematic equations, and key parameters (e.g., velocities, accelerations, link geometry) required to formulate an analytical solution for general plane motion of a rigid body. (P.I.- 2.1.3).*	
05.	**Kinetics of Particle: D'Alembert's** ***Learning Objective:*** *To understand the concept of kinetics of particle and the different methods to solve the engineering problems.*	**04-06**
	Contents:	
	Introduction to basic concepts of D'Alembert's Principle, Concept of Inertia force, Equations of Dynamic Equilibrium, (Analysis limited to simple systems only.) **Work – Energy Principle:** Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs. **Impulse – Momentum Principle:** Principle and Application of Impulse Momentum Principle to particles in motion. **Impact and Collisions:** Law of conservation of momentum, Coefficient of Restitution, Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	
	Self-Learning Topics: *Dynamic Equilibrium*	
	Learning Outcomes: *A learner will be able to*	
	LO 5.1: Apply D'Alembert's Principle to investigate the particles in dynamic equilibrium, (P.I.-1.3.1) *LO 5.2: Apply mechanical engineering knowledge to use work-energy principle for mechanical systems(P.I.-1.4.1).* *LO 5.3: Identify the key mathematical relationships and physical principles such as the work–energy equation and the impulse–momentum theorem required to model and analyze dynamic particle systems. (P.I.-2.1.3).* *LO 5.4: Breakdown a multi-body collision scenario in a force system into sub-problems to facilitate structured problem-solving. (P.I-2.2.1).*	
06.	**Centroid**	**04-06**
	Learning Objective: *To understand the importance of Centroid which can affect the stability of the objects in the real life situations.*	
	Contents: First Moment of Area. Centroid of Composite Plane Lamina.	
	Self-Learning Topics*: Methods for calculating the First Moment of Area.*	
	Learning Outcomes: *A learner will be able to*	

	LO 6.1: Apply fundamental knowledge to find first moment of area. (P.I.-1.1.1). *LO 6.2: Apply mechanical engineering knowledge to find centroid of composite body(P.I.-1.4.1).* *LO 6.3: Implement agreed team roles and norms to collaboratively divide a composite lamina into basic shapes and compute its centroid. (P.I.- 8.1.2)* *LO 6.4: Lead team discussions to select modelling assumptions and resolve conflicts when determining the centroid of complex shapes. (P.I.-8.2.1)* *LO 6.5: Write a concise technical note on centroids of composite areas, using clear diagrams, logical steps, and concise engineering language. (P.I. - 9.1.2)* *LO 6.6: Present your centroid analysis orally with proper engineering terminology and visual aids, and answer audience questions accurately. (P.I. - 9.2.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems.
1.1.2	Apply advanced mathematical techniques to model and solve mechanical engineering problems.
1.2.1	Apply laws of natural science to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply Mechanical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub problems.
2.3.1	Combine scientific principles and engineering concepts to formulate model(s) (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
8.1.2	Implement the norms of practice (e.g., rules, roles, charters, agendas, etc.) of effective teamwork to accomplish a goal.
8.2.1	Collaborate effectively as part of a team in laboratory or real-world engineering tasks.
9.1.2	Communicate effectively in writing using diagrams, logical structure, and engineering terminology.
9.2.1	Prepare and present engineering information effectively in written form—such as technical reports, design documents, and project proposals—using clear, concise language, correct grammar, appropriate structure, and professional formatting.
9.2.2	Deliver effective oral presentations to technical and non-technical audiences.

Course Outcomes:

A learner will be able to -

1. Apply principles of equilibrium and friction to determine support reactions and resultant forces in various mechanical systems, and analyze coplanar force systems while effectively collaborating in teams and presenting solutions in a structured technical format. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6, LO 2.7, LO 2.8)*
2. Apply mathematical and mechanical engineering principles to analyze and interpret linear and projectile motion of objects in real-life situations. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Apply engineering and mathematical concepts to analyze the general plane motion of rigid bodies and mechanisms both graphically and analytically. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Apply principles of dynamics, work-energy, and impulse-momentum to analyze force systems in motion, including collisions and dynamic equilibrium. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Apply principles of engineering mechanics to determine the centroid of composite bodies and communicate the results effectively in collaborative settings. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, LO 6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESC101.1	3	3	-	-	-	-	-	3	3	-	-
ESC101.2	3	3	-	-	-	-	-	-	-	-	-
ESC101.3	3	3	-	-	-	-	-	-	-	-	-
ESC101.4	3	3	-	-	-	-	-	-	-	-	-
ESC101.5	3	-	-	-	-	-	-	3	3	-	-
Average	**3**	**3**	-	-	-	-	-	**3**	**3**	-	-

Text Books :

1. Engineering Mechanics by A K Tayal, Fourteenth Edition, 2011 Umesh Publication.
2. Engineering Mechanics by Kumar, Fourth Edition, 2017 Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Third Edition, 1975, Harper & Raw
4. Engineering Mechanics by R. C.Hibbeler , Fourth Edition, 2017, Pearson Education

Reference Books :

1. Engineering Mechanics by Beer &Johnston, Fourth Edition, 1987 ,Tata McGraw-Hill
2. Engineering Mechanics (Statics) by Meriam and Kraige, Fourth Edition, 1999 Wiley Books

Other Resources :

1. NPTEL Course: NOC Engineering Mechanics Statics and Dynamics by Prof. Mahesh Panchagnula offered by IIT Madras Web link: https://nptel.ac.in/courses/112/106/112106180

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. Numerical Assignments (minimum 20 problems): 5 Marks
2. Class Test based on similar problems which were given as an assignment: 5 Marks
3. Think-Pair and share: 5 Marks
4. Regularity and active participation: 5 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
ESC	ESC102	BASIC ELECTRICAL ENGINEERING	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The engineer and the world
4. PO8: Individual and teamwork

Course Objectives:

1. To impart knowledge on fundamentals of electrical power system, conventional and non- conventional energy sources.
2. To impart knowledge on basic electrical systems, DC circuits, AC circuits, Residential Electrical System, Residential Energy Metering and Electrical Machines to solve engineering problems.
3. To introduce concept to analyse DC circuits, AC circuits.
4. To introduce safety devices incorporated in residential electrical system for professional engineering practice.

Module	Detailed Content	Hrs
00	**Course Introduction** Overview of Basic Electrical Engineering, application of Basic Electrical Engineering in Industry/real life problem. It is a foundational course designed to provide students with a comprehensive understanding of fundamental electrical concepts and principles.	**1**
01.	**Introduction to Basic Electrical Systems** ***Learning Objective/s:*** *To acquire knowledge on various components of electrical powers system and compare different sources of electrical energy.*	**2-4**
	Contents: Components of Electrical power System, Role of each component, Structure of electrical power system, Introduction to transformer, Conventional sources of electric energy, Renewable energy sources, Comparison of various energy sources.	

	Self-Learning Topics: *Comparison of conventional and nonconventional energy sources.* ***Learning Outcomes:*** *A learner will be able to* *LO1.1 Apply the concepts of electrical engineering to understand role of each component of electrical power system. (P.I.-1.4.1)* *LO1.2Apply basic principles of transformers to understand their function within the electrical power system. (P.I.-1.3.1)* *LO1.3 Apply fundamental engineering concepts to compare different sources of electrical energy. (P.I.-1.2.1)*	
02.	**DC Circuits with independent sources** ***Learning Objective/s:*** *To apply the concepts of various theorems and laws to analyze DC circuits.*	**5-7**
	Contents: Ohm's Law, Kirchhoff's Laws, Star Delta transformation, Ideal and practical voltage and current sources, Mesh and Nodal Analysis, Superposition theorem, Thevenin's theorem, Maximum power transfer theorem.	
	Self-Learning Topics: *Series and parallel connections of resistances.* ***Learning Outcomes:*** *A learner will be able to* *LO2.1 Apply concepts of Ohm's law and Kirchoff's laws to solve DC circuits. (P.I.- 1.4.1)* *LO2.2 Apply concepts of star delta transformation to simplify DC circuits. (P.I.-1.3.1)* *LO2.3 Identify network theorems to determine current distribution in DC circuits. (P.I.- 2.1.3)* *LO2.4 Identify the impact of ideal and practical electrical sources on the analysis of DC circuits. (P.I.-2.1.2)*	
03.	**AC Fundamentals** ***Learning Objective/s:*** *To analyze AC circuit and interpret the condition of resonance by using concepts of current, voltage, power factor and power calculation in AC circuits.*	**5-7**
	Contents: Single-phase AC series circuits consisting of R, L, C, RL, RC, RLC combinations, definitions -real, reactive, and apparent power. Series Resonance.	
	Self-Learning Topics: *Parallel AC circuits.* ***Learning Outcomes:*** *A learner will be able to* *LO3.1 Produce phasor expressions for sinusoidal quantities in AC circuits and validate AC circuit analysis by applying concepts of phasor algebra. (PI – 2.4.2)* *LO3.2 Identify the behavior of single-phase AC series circuits with R, L, C, RL, RC, and RLC combinations using phasor diagrams and impedance concepts. (P.I.-2.1.2)* *LO3.3 Apply concepts of AC power analysis to calculate real, reactive, and*	

	apparent power in single-phase AC series circuits. (P.I.-2.4.1) *LO3.4 Identify condition of resonance and calculate resonant frequency by overserving current and reactance in series AC circuits. (P.I.-2.1.3)*	
04.	**Residential Electrical Systems** ***Learning Objective/s:*** *To acquire knowledge on residential electrical wiring incorporating suitable safety devices, testing and up-keeping of household electrical appliances and residential lighting system.*	**4-6**
	Contents: Components of residential electrical system, Residential wiring System, load calculation, Electrical safety Devices, Fuse, MCB, ELCB, grounding issues, safety precautions, testing of domestic appliances and up-keeping, Luminous flux, Luminous intensity, Lumination, Types of lamps in residential lighting. Case study on residential lighting.	
	Self-Learning Topics: *Basic requirements of electrical system.* ***Learning Outcomes:*** *A learner will be able to* *LO4.1 Apply knowledge of basic system requirements to identify and understand components of a residential electrical system. (P.I.-1.3.1)* *LO4.2 Apply basic electrical engineering concepts to test and repair domestic electrical appliances. (P.I.-1.4.1)* *LO4.3 Identify and explain the concepts of luminous flux, luminous intensity, and illumination, and differentiate between various types of lamps used in residential lighting. (P.I.-2.2.4)* *LO4.4 Identify variables and parameters required to solve illumination design problem. (P.I-2.1.2)* *LO4.5 Identify appropriate safety devices for protecting residential electrical systems based on the type and rating of the connected load. (P.I.- 6.1.1)* *LO4.6 Interpret codes and standards relevant to electrical protective devices. (P.I.- 6.2.1)* *LO4.7 Demonstrate teamwork by conducting and collaboratively presenting a case study on residential lighting system design. (P.I.-8.2.1, 8.3.1)*	
05.	**Introduction to Residential Energy Measurements** ***Learning Objective/s:*** *To acquire knowledge on residential energy metering, energy tariff and understanding the residential electricity bill.*	**2-4**
	Contents: Measurement of Energy, Understanding of electricity bill, energy tariff electricity bill calculation.	

	Self-Learning Topics: *Types of meters used for energy metering.* ***Learning Outcomes:*** *A learner will be able to* *LO5.1 Apply concepts of electrical engineering to calculate the electrical energy consumed over a specified time. (P.I.-1.4.1)* *LO5.2 Apply government regulations to calculate electrical energy tariff based on meter readings.(P.I.-1.3.1)*	

06.	**Introduction to Electrical Machines** ***Learning Objective/s:*** *To identify motors for given application using concepts of construction, working and characteristics of different machines.*	**4-6**
	Contents: Construction, working, characteristics and application of DC machines, Single phase Induction Motor, Servo motors, Brushless DC motor, Stepper motor. Factors to be considered for selection of motor and its rating. Selection of motors from motor and load characteristics.	
	Self-Learning Topics: *Working principle of electric motor.* ***Learning Outcomes:*** *A learner will be able to* *LO6.1 Apply fundamental engineering concepts to differentiate various machines based on their construction and working principles. (P. I-1.3.1)* *LO6.2 Apply Electrical engineering concepts to understand the characteristics and applications of various machines. (P. I-1.4.1)* *LO6.3 Identify and compare electrical motors for given application based on characteristics of load and motor. (P.I.-2.2.4)* *LO6.4 Identify the rating of motor by considering factors like power, speed, torque etc. of the given application. (P.I.-2.2.3)*	
	Course Conclusion	**1**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply Electrical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline

and explain its contribution to the protection of the public

8.2.1 Demonstrate effective communication, problem solving, and conflict resolution and leadership skills.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.

Course Outcomes:

Learner will be able to

1. Apply fundamental engineering concept to interpret Basic Electrical Systems, Residential Electrical System and Residential Energy Metering. (*LO1.1, LO1.2, LO1.3, LO5.1)*
2. Apply concepts of electrical engineering to solve problems on DC circuits and AC circuits. *(LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO3.3, LO3.4)*
3. Interpret and identify safety devices for professional engineering practice. (*LO4.5, LO4.6*)
4. Apply fundamental lighting engineering concepts to solve basic residential lighting design problems. *(LO4.1, LO4.2, LO4.3, LO4.4, LO4.7, LO5.2)*
5. Identify electrical motors based on requirement of application and characteristics of motor. *(LO6.1, LO6.2, LO6.3, LO6.4)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESC102.1	3										
ESC102.2	3	3									
ESC102.3						3					
ESC102.4	3							3			
ESC102.5	3	3									
Average	3	3				3					

Text Books:

1. Electrical Power Systems,S.L. Uppal and Prof. Sunil S. Rao 15th Edition, Khanna Publishers
2. Basic Electrical Engineering, B.R Patil, 2nd Edition Oxford Higher Education, 2019
3. Art & Science of Utilization of electrical Energy, H Partab, Dhanpat Rai & Co., 2004.
4. Electrical and Electronic Measurements and Measuring Instruments, A K Sawhney Dhanpat Rai and Sons
5. Special Electrical Machines, E G Janardanan PHI 2014
6. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao, 15th Edition, Khanna Publishers

Reference Books:

1. Power System Engineering, D P Kothari and I J Nagrath, 3rd Edition, Mac Graw Hills,
2. Electrical Engineering Fundamentals, Vincent Del Toro, PHI Second edition, 2011
3. Utilization of Electric Power & Electric Traction, J B Gupta, 10th Edition, Dhanpat Rai and Sons 2012.
4. Electrical Engineering, B.L.Theraja Vol-I and II

5. Basic Electrical Engineering, S.N.Singh PHI, 2011

Other Resources:

1. NPTEL course on Basic Electrical Technology, IISc Bangalore Prof. L. Umanand https://nptelvideos.com/course.php?id=460

IN-SEMESTER ASSESSMENT (35 Marks)

1. **Continuous Internal Evaluation of Theory (15 Marks)**

   Numerical Assignments (minimum 20 problems): 4 Marks

   Class Test based on similar problems which were given as an assignment: 4 Marks

   Open book test/Open notes test: 4 Marks

   Regularity and active participation: 3 Marks

2. **Mid Semester Exam (20 Marks)**

   Mid semester examination will be based on 40 % to 50% of the syllabus.

End Semester Exam (40 Marks)

End semester will be based on the syllabus coverage upto Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
BSC-LC	BSL101	ENGINEERING PHYSICS-I LABORATORY	0.5

Examination Scheme					
Distribution of Marks			**Exam Duration (Hrs.)**		**Total Marks**
In-semester Assessment		**End Semester Examination (ESE)**			
Continuous Assessment	**Mid-Semester Exam (MSE)**		**MSE**	**ESE**	
25	-	-	-	-	25

Program Outcomes addressed:

1. PO1:Engineering Knowledge
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and collaborative team work
4. PO9: Communication

Course Objectives:

1. To demonstrate the fundamental concepts of physics and evaluate the process of an experiment/project quantitatively and qualitatively.
2. To improve the knowledge gained in the theory course.
3. To develop the abilities of measurements, observations and analyzing data.
4. To develop the experimental skill in assembling and handling laboratory instruments.

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Experiment 1:** ***Learning Objective:*** ***To use Newton's rings for the determination of various physical quantities.***	
	Determination of the radius of curvature (R) of given plano convex lens using Newton's Rings	
	Learning Outcome: *LO 1.1: A learner will be able to* *apply the concepts of interference in thin film and analyze the experimental data to calculate radius of curvature of the given plano convex lens. (P.I.1.2.1, P.I.1.3.1, P.I. 4.3.1, P.I..4.3.3)*	

02.	Experiment 2 ***Learning Objective:*** ***To study the applications of diffraction grating.*** Measurement of wavelength of He-Ne laser by using grating ***Learning Outcome:*** *LO 2.1: A learner will be able to apply the concepts of diffraction through multiple slit and analyze the experimental data to calculate wavelength of the laser source. (P.I.1.2.1, P.I.1.3.1, P.I. 4.3.1, P.I..4.3.3)*	**02**
03.	**Experiment 3** ***Learning Objective:*** ***To determine the parameters which defines the characteristics of an optical fibre.*** Measurement of Numerical aperture of an Optical Fibre. ***Learning Outcome:*** *LO 3.1: A learner will be able to apply the knowledge of optical fibre and analyze the experimental data to calculate numerical aperture of the given fibre. (P.I.1.2.1, P.I.1.3.1, P.I. 4.3.1, P.I..4.3.3)*	**02**
04.	**Experiment 4** ***Learning Objective:*** ***To determine various physical quantities by using Hall effect in semiconductors*** Determination of magnetic field using Hall-effect setup. ***Learning Outcome:*** *LO 4.1: A learner will be able to apply the concept of Hall effect phenomena and analyze the experimental data to calculate magnetic field generated by electromagnet. (P.I.1.2.1, P.I.1.3.1, P.I. 4.3.1, P.I..4.3.3)*	**02**
05.	**Experiment 5** ***Learning Objective:*** ***To study V-I characteristics of semiconductor devices*** Voltage-current (V-I) characteristic of photo diode ***Learning Outcomes:*** *LO 5.1: A learner will be able to apply the working principle of photodiode and analyze the V-I characteristic curve to draw conclusion. (P.I.1.2.1, P.I.1.3.1, P.I. 4.3.1, P.I..4.3.3)*	**02**
06.	**Course Project** ***Learning Objective/s:*** ***To explore the application of concept of physics in different fields by selecting a project.*** Selection of a project based on physics concepts, Literature survey, and Topic presentation.	**03**

	Learning Outcome: *LO 6.1: A learner will be able to identify a project based upon the concepts of physics and present the topic effectively as a team.* ***(P.I.1.2.1, P.I.1.3.1, P.I..8..1.2, P.I. 8.3.1, P.I. 9.1.1, P.I. 9.2.2)***	
	Course Conclusion	**01**
	Total	**15**

Performance Indicators:

P.I. No. P.I. Statement

1.2.1 Apply laws of natural science to an engineering problem.

1.3.1 Apply fundamental engineering concepts to solve engineering problems.

4.3.1 Use appropriate procedures, tools and techniques to conduct experiments and collect data.

4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.

8.1.2. Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective teamwork to accomplish a goal.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.

9.1.1 Produce clear, well-constructed, and well- supported written engineering documents.

9.2.2 Deliver effective oral presentations to technical and non- technical audiences.

Course Outcomes: A learner will be able to -

1. A learner will be able to apply the fundamental knowledge of optical phenomena to determine various parameters through relevant experiments.(*LO 1.1, LO 2.1, LO3.1*)
2. A learner will be able to apply the fundamental knowledge of semiconductor devices to determine various parameters through relevant experiments. (*LO4.1, LO5.1*)
3. A learner will be able to apply the fundamental knowledge of physics to present proposed project work, write effective reports as a team. (*LO 6.1)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSL101.1	3			3							
BSL101.2	3			3							
BSL101.3	3							3	3		
Average	3			3				3	3		

Text Books :

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications

Reference Books :

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
3. Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1 st Edition, Wiley-Interscience.

Other Resources :

1. Online physics library, California State University:-Web linkhttps://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.ed

IN-SEMESTER ASSESSMENT (25 MARKS)

1. Lab Performance: 10 Marks
2. Project (Final Report and Demonstration): 10 marks
3. Regularity and active participation: 5 marks

Course Type	Course Code	Course Name	Credits
BSL	BSL102	ENGINEERING CHEMISTRY - I LABORATORY	0.5

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
25	-	25	25	-	25

Pre-requisite:

1. Nil

Program Outcomes addressed:

1.	PO1: Engineering Knowledge
2.	PO2: Problem Analysis
3.	PO4:Conduct investigation of complex problems
4.	PO6: The engineer and the world
5.	PO8: Individual and collaborative teamwork
6.	PO9: Communication
7.	PO11: Life-Long Learning

Course Objectives:

1. To enable the students to utilize fundamental laboratory techniques for analysis and synthesis of chemical products.
2. To enable the students to learn various laboratory safety rules in standard laboratory practices.

Module	Details	Hrs.
	Course Introduction 1. Laboratory familiarization 2. Code of conduct in chemistry laboratory 3. Safety and precautions to be observed in chemistry laboratory 4. Orientation on evaluation of laboratory performance	**01**
01.	**Experiment 1** *Learning Objective:* *To estimate the total, temporary and permanent hardness of water using EDTA method to understand its quality for industrial use.*	**02**
	Estimation of Total, temporary and permanent hardness of water by EDTA method.	

	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO-1.1 Analyse the quality of the industrial water by calculating the total hardness using complexometric titration method. (1.2.1) (1.3.1) (2.1.3) (2.2.3) (4.3.1) (4.3.3)*	
02.	**Experiment 2** *Learning Objective:* *To determine the chloride content of water to understand its suitability for domestic use.*	**02**
	Estimation of chloride content of water sample	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO- 2.1 Analyse the quality of the drinking water by calculating the chloride content using precipitation titration method.* *(1.2.1) (1.3.1) (2.1.3) (2.2.3) (4.3.1) (4.3.3)*	
03.	**Experiment 3** *Learning Objective:* *To synthesize aspirin by using acetylation process and calculate it's percent yield and atom economy to determine the nature of reaction.*	**02**
	To synthesize aspirin from salicylic acid	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO-3.1 Synthesize aspirin using acetylation process and calculate its percentage yield (1.2.1) (1.3.1) (2.2.3) (2.3.1) (4.3.1) (4.3.3)*	
04.	**Experiment 4** *Learning Objective:* *To calculate the enthalpy of dissolution of copper sulphate in water using simple calorimeter.*	**02**
	To determine the enthalpy of dissolution of copper sulphate at room temperature using water as a reaction medium.	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO-4.1 Calculate enthalpy of the given system using first law of thermodynamics. (1.2.1), (1.3.1), (4.1.3) (4.3.1) (4.3.3)*	
05.	**Experiment 5** ***Learning Objective:*** ***To determine the effect of various factors affecting the rate of corrosion of iron***	**02**
	To determine the factors affecting the rate of corrosion.	

	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO-5.1 Determine the effect of various factors on the rate of corrosion by applying the knowledge of electrochemistry (1.2.1) (1.3.1) (4.3.1) (4.3.3)*	
06.	**Designing of experiment and presentation:** ***Learning Objective/s:*** *To develop the basic knowledge of analytical chemistry using titrimetric experiments*	**03**
	Standardization/estimation of chemical substances using titrimetric analysis.	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO-6.1 Identify the existing titrimetric analysis to estimate the given substance and present the result as a team. (1.2.1) (1.3.1), (4.2.1) (4.3.1) (4.3.3) (8.1.1), (8.3.1) (9.1.1), (9.1.2), (9.1.3) (11.3.1) (11.3.2).*	
	Course Conclusion	**01**
	Total	**15**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem.
1.3.1	Apply fundamental engineering chemistry concepts to solve engineering problems.
2.1.3	Identify the engineering chemistry concepts to analyse the given problem
2.2.3	Identify the existing processes/ solution methods for solving the problems
2.3.1	Combine the scientific principles and engineering chemistry concepts to formulate a drug
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures.
4.1.3	Apply appropriate instrumentation to make measurements of physical and chemical quantities.
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data.
4.3.3	Represent data in tabular/ graphical forms so as to facilitate analysis and explanation of the data and drawing of conclusions.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
8.3.1	Present result as a team with smooth integration of contributions from all individual efforts.

9.1.1 Read, understand and interpret technical and non-technical information
9.1.2 Produce clear, well-constructed, and well-supported written project report.
9.1.3 Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.2 Deliver effective oral presentations to technical and non-technical audiences.
11.3.1 Source and comprehend technical literature and other credible sources of information
11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Apply the laws of electrochemistry and thermodynamics for performing the practicals. *(LO-4.1, LO-5.1)*
2. Formulate a drug by applying the concepts of chemistry. *(LO-3.1)*
3. Analyse the quality of water for assessing the public health. *(LO-1.1, LO-2.1)*
4. Demonstrate an ability to work effectively in a team for project-based activity. *(LO-6.1)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSL102.1	3			3							
BSL102.2	3	3		3							
BSL102.3	3	3		3							
BSL102.4	3			3				3	3		3
Average	3	3		3				3	3		3

Textbooks:

1 Practical book in Engineering Chemistry by Dr. Pijus Khatua and Debashree Singh, First edition, 2016, Platinum Publishers
2 Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

Reference Books:

1 Engineering Chemistry by Jain and Jain, 17th edition, 2018, Dhanpatrai publications

2 Experiments in Engineering Chemistry by Payal Joshi, first edition, 2016, I.K. International Publishing House Pvt. Ltd.

Other Resources:

1 Online chemistry library for open access textbooks: https://chem.libretexts.org

2 Lab Simulation: https://vlab.amrita.edu/?sub=2&brch=190&sim=1546&cnt=1

IN-SEMESTER ASSESSMENT (25 MARKS)

1. Lab Performance: 10 Marks
2. Design experiment and presentation: 10 marks
3. Regularity and active participation: 5 marks

Course Type	Course Code	Course Name	Credits
ESL	ESL101	ENGINEERING MECHANICS LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam**	**Total Marks**
25	--	25

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering Tool Usage
4. PO8: Individual and team work
5. PO9: Communication

Course Objectives:

1. To demonstrate the equilibrium of coplanar forces
2. To demonstrate law of moments.
3. To determine coefficient of friction between two different surfaces in contact.
4. To analyse the motion of particle.

Module	Details	Hrs.
	Course Introduction The Engineering Mechanics Lab Course marks the transition from physics to engineering applications. This course develops the ability to apply and analyze, which are paramount in engineering profession.	**01**
01.	**Coplanar Force System** ***Learning Objective:*** *Learner will be able to apply fundamental engineering concepts to demonstrate the concept of equilibrium of coplanar forces.*	**08-10**
	Experiment 1: To verify polygon law of forces	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to verify the Law of Polygon of Forces by constructing force polygons graphically and solving for equilibrium conditions by identifying equilibrium equations in a team and document the results in a detailed report. (P.I.-1.3.1, P.I.-2.1.2, P.I.-8.2.1, P.I.-9.1.2)*	
	Experiment 2: To verify Lami's theorem using simple Jib Crane	
	Learning Outcomes: *A learner will be able to* *LO 1.2: Apply mechanical engineering concepts to verify Lami's theorem by identifying the equilibrium conditions and calculating forces both analytically and experimentally. Work Collaboratively to prepare a technical report with clear written analysis. (P.I.-1.4.1, P.I.-2.1.3, P.I.-8.2.1, P.I.-9.1.2)*	

	Experiment 3: To determine the reactions of simply supported beam.	
	Learning Outcomes: *A learner will be able to* *LO 1.3: Apply fundamental engineering concepts to determine support reactions by using equilibrium conditions at various load positions. Discuss in to compare observed and calculated reactions, analyze discrepancies, and prepare a detailed report with clear explanations and annotated diagrams. (P.I.-1.3.1, P.I.-2.1.3, P.I.-8.2.2, P.I.-9.1.2, P.I.-9.3.1)*	
02.	**Principle of Moment**	**02-04**
	Learning Objective: *Learner will be able to apply mechanical engineering concepts to demonstrate the principle of Moments using the Bell Crank Lever apparatus.*	
	Experiment 4: To verify moment equilibrium condition using bell crank lever.	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental and mechanical engineering concepts to verify the Principle of Moments by measuring spring tensions and hanger forces at various arm positions. Collaborate in teams to conduct repeated trials and compare experimental values with theoretical results, and prepare a detailed report. (P.I.-1.3.1, P.I.-1.4.1, P.I.-2.1.3, P.I.-2.2.3, P.I.-8.2.1, P.I.-8.3.1, P.I.-9.1.2, P.I.-9.3.1)*	
03.	**Friction**	**04-06**
	Learning Objective: *Learner will be able to determine coefficient of friction between two different surfaces in contact.*	
	Experiment 5: To determine coefficient of friction using friction plane and angle of repose method.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply natural science laws and fundamental engineering concepts to measure static and kinetic friction coefficients by identify appropriate analytical approaches and justified assumptions. Collaborate in teams to conduct repeated trials and produce a clear written report with structured narrative and standard figures. (P.I.-1.2.1, P.I.-1.3.1, P.I.-2.1.3, P.I.-2.2.3, P.I.-8.2.1, P.I.-8.3.1, P.I.-9.1.2, P.I.-9.3.1)*	
04.	**Kinematics of particles**	**08-10**
	Learning Objectives: *Learner will be able to analyze the motion of particle.*	
	Experiment 6: To study the motion of the projectile.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the laws of natural science and fundamental engineering concepts to measure range and impact velocity at varied launch angle by identifying variables and parameters to apply kinematics relations, coordinate with team members and prepare a technical report. (P.I.-1.2.1, P.I.-1.3.1, P.I.-2.1.2, P.I.-8.1.2, P.I.- 9.1.2)*	

	Experiment 7: To measure and verify average speed of the vehicle.	
	Learning Outcomes: *A learner will be able to* *LO 4.2: Apply fundamental engineering concepts to identify necessary mathematical and engineering principles to calculate and verify the glider's average speed by positioning photogates at a known distance. Work in a team to process and interpret timing data in a logical manner to prepare a detailed written report. (P.I.-1.3.1, P.I.-2.1.3, P.I.-8.2.2, P.I.-9.1.1, P.I.- 9.1.2)*	
	Experiment 8: Study of linear and curved motion under low friction and plot distance, velocity, and acceleration as a function of time.	
	Learning Outcomes: *A learner will be able to* *LO 4.3: Apply mechanical engineering concepts to conduct linear and curved-track experiments using a wireless motion encoding car and data acquisition software to verify the relationships among displacement, velocity, acceleration by collaborating effectively in team to prepare a technical report. (P.I.-1.4.1, P.I.-5.1.1, P.I.-5.2.2, P.I.-8.2.1, P.I.-9.1.2)*	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I.	P.I. Statement
1.2.1	Apply laws of natural science to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply Mechanical engineering concepts to solve engineering problem.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering, and other relevant knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
5.1.1	Identify modern engineering tools, techniques, and resources
5.2.2	Demonstrate proficiency in using discipline-specific tools
8.1.2	Demonstrate the ability to function effectively as a member of a diverse, multidisciplinary team to achieve a common engineering goal.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.2.2	Apply leadership and team-management skills to coordinate tasks, resolve conflicts, and uphold accountability among team members to achieve shared project objectives.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
9.3.1	Create engineering-standard figures, reports, and drawings to complement writing and presentations.

Course Outcomes:

A learner will be able to

1. Apply fundamental mechanics principles and analyze static equilibrium in coplanar force experiments by classifying force systems, constructing and resolving free-body diagrams, and calculating support reactions using both analytical equations and graphical methods. *(LO 1.1, LO 1.2, LO 1.3)*
2. Apply mechanical engineering concepts and analyze moments and couples through bell-crank lever experiments by formulating equilibrium equations, measuring spring tensions and hanger forces, and comparing theoretical and experimental results. *(LO 2.1)*
3. Apply laws of natural science and mechanical engineering principles to analyze frictional behaviour by measuring static and kinetic coefficients via friction-plane and angle-of-repose methods, evaluating multiple techniques, and interpreting surface and material effects. *(LO 3.1)*
4. Apply kinematic principles using modern instrumentation and analyze by conducting projectile, photogate, and wireless motion encoding car experiments to collect real-time data, and deriving displacement, velocity, acceleration, force, and energy relationships in clear technical reports. *(LO 4.1, LO 4.2, LO 4.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESL101.1	3	3	-	-	-	-	-	3	3	-	-
ESL101.2	3	3	-	-	-	-	-	3	3	-	-
ESL101.3	3	3	-	-	-	-	-	3	3	-	-
ESL101.4	3	3	-	-	3	-	-	3	3	-	-
Average	**3**	**3**	-	-	**3**	-	-	**3**	**3**	-	-

Text Books :

1. Engineering Mechanics by A K Tayal, Fourteenth Edition, 2011 Umesh Publication.
2. Engineering Mechanics by F. L. Singer, Third Edition, 1975, Harper & Raw
3. Engineering Mechanics by R. C.Hibbeler , Fourth Edition, 2017, Pearson Education

Reference Books :

1. Engineering Mechanics by Beer &Johnston, Fourth Edition, 1987 ,Tata McGraw-Hill
2. Engineering Mechanics (Statics) by Meriam and Kraige, Fourth Edition, 1999 Wiley Books

IN-SEMESTER ASSESSMENT (25 MARKS)

Continuous Assessment – Lab Session

1. Practical performance based on all the experiments mentioned in the syllabus with proper understanding : 10 Marks
2. Oral evaluation on experiments conducted on Statics :5 Marks
3. Oral evaluation on experiments conducted on Dynamics:5 Marks
4. Regularity and active participation: 5 Marks

Course Type	Course Code	Course Name	Credits
ESL	ESL102	BASIC ELECTRICAL ENGINEERING LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam(ESE)**	**Total Marks**
25	25	50

Pre-requisite:

1. ESC102: Basic Electrical Engineering

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO 2: Problem Analysis
3. PO4: Conduct investigations of complex problems
4. PO8: Individual and teamwork
5. PO9: Communication

Course Objectives:

1. To impart the knowledge on the analysis and applications of D.C. circuits and single-phase AC circuits.
2. To impart the knowledge on the elements of residential electrical system, appliances and electrical safety.
3. To impart the knowledge on the construction, working principle of transformer and motors and selection of motor for a specific application.

Module	Detailed Contents	Hrs
00	**Course Introduction** The Basic Electrical Lab course is designed to introduce fundamental concepts in electrical engineering through hands-on laboratory experiments. Through a series of practical exercises, students will develop essential skills for working with basic electrical components and circuits.	**01**
01.	**Experiment:** Analyze DC circuit using mesh and nodal analysis by assembling the given circuit on a breadboard and verifying the results through manual calculations.	**04**
	Learning Outcomes: *A learner will be able to* *LO1.0 Assemble given circuit on breadboard to verify Ohm's law, Kirchhoff's laws, mesh analysis and nodal analysis practically by using DC power supply, multimeter, ammeter and voltmeter in a group. Compare practical results with theoretical calculations and prepare a detailed report. (P.I.-1.3.1,1.4.1, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	
02.	**Experiment:** Analyze the given DC circuit using Thevenin's, Norton's, and Maximum Power Transfer theorems through practical implementation and theoretical calculations.	**03**

	Learning Outcomes: *A learner will be able to* *LO2.0 Assemble circuit on breadboard and use DC power supply, multimeter, ammeter and voltmeter for measuring current and voltage in DC circuits in a group to verify Thevenin's theorem, Norton's theorem and Maximum power transfer theorem in a DC circuit and summarize results in a report. (P.I.-1.3.1,1.4.1, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	
03.	**Experiment:** Determine the inductance and resistance of the choke coil in series circuit and verify the results by manual calculation. ***Learning Outcomes:*** *A learner will be able to* *LO3.0 Determine the inductance of a choke coil by measuring the voltage across and current through a series and parallel connected resistance and choke coil and summarize the results in a report. (P.I.-1.3.1,1.4.1, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**02**
04.	**Experiment:** Measure the resonant frequency in RLC series and parallel circuit and plot current vs frequency curve. ***Learning Outcomes:*** *A learner will be able to* *LO4.0 Measure the resonance frequency in RLC series and parallel circuit and plot resonance curve. (P.I.-1.3.1,1.4.1, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**04**
05.	**Experiment:** Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, MCB, ELCB, MCCB etc. Identify make and rating of above devices used in your house. ***Learning Outcomes:*** *A learner will be able to* *LO5.0 Assemble small electrical circuits like test boards / extension boards similar to residential wiring system along with safety devices and submit a report. (P.I.-1.3.1,1.4.1, 2.1.2, 2.2.4, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**04**
06.	**Experiment:** Wire up PVC conduit wiring to control one lamp from two different places. ***Learning Outcomes:*** *A learner will be able to* *LO6.0 Demonstrate the ability to design and implement a two-way control circuit using PVC conduit wiring to operate a lamp from two locations in a group. (Staircase wiring) (P.I.-4.1, 4.1,3, 4.1.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**02**
07.	**Experiment:** Dismantle and assemble electrical parts of domestic electric appliances like electric iron, fan etc. ***Learning Outcomes:*** *A learner will be able to* *LO7.0 Maintenance and up-keeping of household electrical appliances and submit a report in a group. (P.I.- 1.4.1, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**02**

08.	**Experiment:** Verify terminals, polarity, identify components and calculate transformation ratio of single-phase transformers. ***Learning Outcomes:*** *A learner will be able to* *LO8.0 Verify terminals, polarity, study the name plate details and calculate transformation ratio of single-phase transformers. (P.I.-2.1.2, 2.2.4, 8.1.1,8.1.2, 9.1.2, 9.1.3)*	**02**
09.	**Experiment:** Identify and understand the construction and function of various parts of electric motors through visual inspection and hands-on exploration. ***Learning Outcomes:*** *A learner will be able to* *LO9.0 Recognize and explain the construction, components, and functional aspects of different types of electric motors through practical observation and interaction. (P.I.- 8.1.1, 8.1.2, 9.1.2, 9.1.3)*	**02**
10.	**Experiment:** Study and identify suitable types of electrical motors for specific applications based on their characteristics and operational requirements. ***Learning Outcomes:*** *A learner will be able to* *LO10.0 Identify and select appropriate types of electrical motors for various applications by analyzing their characteristics and functional requirements.(P.I.-2.1.2, 2.2.4, 8.1.1, 8.1.2, 9.1.2, 9.1.3)*	**04**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.2.4	Compare and contrast alternative solution processes to select the best process.
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities.
4.1.4	Establish a relationship between measured data and underlying physical principles.
4.2.1	Design and develop experimental approach, specify appropriate equipment and procedures
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear

Course Outcomes:

Learner will be able to

1. Assemble the DC and AC circuits on breadboard and test the continuity. *(LO1.0, LO2.0, LO3.0, LO4.0, LO5.0)*
2. Select the meters to measure the required variables and analyse the performance of DC and AC circuits. *(LO1.0, LO2.0, LO3.0, LO4.0)*
3. Assemble simple residential electrical wiring incorporating safety devices. (*LO5.0, LO6.0)*
4. Select motor for household applications and test the transformer. (*LO7.0, LO8.0, LO9.0, LO10.0)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESCLC102.1	3			3				3	3		
ESCLC102.2	3			3				3	3		
ESCLC102.3	3	3		3				3	3		
ESCLC102.4		3						3	3		
Average	3	3		3				3	3		

Text Books:

1. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao 15th Edition, Khanna Publishers
2. Basic Electrical Engineering, B.R Patil, 2nd Edition Oxford Higher Education, 2019
3. Art & Science of Utilization of electrical Energy, H Partab, Dhanpat Rai & Co., 2004.
4. Electrical and Electronic Measurements and Measuring Instruments, A K Sawhney Dhanpat Rai and Sons
5. Special Electrical Machines, E G Janardanan PHI 2014
6. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao, 15th Edition, Khanna Publishers

Reference Books:

1. Power System Engineering, D P Kothari and I J Nagrath 3rd Edition, Mac Graw Hills,
2. Electrical Engineering Fundamentals, Vincent Del Toro, PHI Second edition, 2011
3. Utilization of Electric Power & Electric Traction, J B Gupta, 10th Edition, Dhanpat Rai and Sons 2012
4. Electrical Engineering, B.L.Theraja Vol-I and II
5. Basic Electrical Engineering, S.N.Singh PHI, 2011

Other Resources:

1. NPTEL course on Basic Electrical Technology, IISc Bangalore Prof. L. Umanand https://nptelvideos.com/course.php?id=460
2. Virtual Lab - https://asnm-iitkgp.vlabs.ac.in

CONTINUOUS ASSESSMENT (25 Marks)

1. **Practical Exercises – 10 Marks**
    1. Readiness to perform experiment (2 Marks),
    2. Performance (2 Marks),
    3. Report writing (2 Marks),
    4. Interpretation of result (2 Marks),
    5. Regularity in submission (2 Marks).
2. **Practical Test 1** (Based on first 50% of practical list) – 5 Marks
3. **Practical Test 2** (Based on remaining 50% of practical list) – 5 Marks
4. Regularity and active participation – 5 Marks

END SEMESTER ASSESSMENT (25 Marks)

Two examiners, one internal and one external will do the evaluation

1. Students will be randomly allocated and experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formulae. It will be checked by the examiners and evaluated out of 05 Marks.
2. Then the student will be allowed to start with the performance of the experiment.
3. Students will be given 1 hour to complete the circuit connection and take readings. The connections and output are verified by the examiners. The weightages 05 Marks.
4. Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
5. Students will be appearing for Oral test front of both Internal and External examiners. The weightage of Oral test will be of 10 marks.

Course Type	Course Code	Course Name	Credits
ESL	ESL103	PROGRAMMING LABORATORY-I (C)	02

Examination Scheme		
Continuous Assessment	**End Semester Exam(ESE)**	**Total Marks**
50	50	100

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering tool usage
4. PO11: Life-long learning

Course Objectives:

1. To provide exposure to problem-solving by developing an algorithm, flowchart and implement the logic using C programming language.
2. To familiarize basics of Conditional and Looping Control Structures in C.
3. To provide exposure about function definition, declaration and its usage and recursive functions.
4. To familiarize one and multi-dimensional arrays and strings in C.
5. To provide exposure about structure, pointers, operations on pointers and dynamic memory allocation in C programming language.

Module	Details	Hrs.
	Course Introduction Knowledge of problem solving and programming concepts is essential for those who develop applications for users. This course imparts basic knowledge in C programming along with the concepts of design and development of programs using C.	**01**
01.	**Introduction to Algorithm, Flowchart and C.** ***Learning Objective:*** *Learner is expected to recall basics of algorithm, flowchart and C. Also expected to understand problem-solving approach and apply the logic to implement program using C. Investigate the functioning of various components of the given control system as a team*	**07**
	Contents: Basic Concept of Problem solving, Introduction to Algorithm and Flowchart. Character Set, Identifiers and keywords, Data types, Constants, Variables. Operators-Arithmetic, Relational and logical, Assignment, Unary, Conditional, Bitwise, Comma, other operators. Expression, statements, Library Functions, Preprocessor. Data Input and Output. Structure of C program. **Task 1:** Algorithm and flowchart to find greatest of three numbers, sum of N natural numbers. *LO 1.1: A learner will be able to apply fundamental problem solving technique to break the problem into logical steps using algorithm and use symbols of flowchart to translate problem statements into visual representation. (P.I. -*	

	1.1.1, P.I. - 1.3.1) **Task 2:** C program to calculate 40% da from basics, 20% hra from basics. Also calculate the gross salary of an employee. (GS=BS+DA+HRA) *LO 1.2: A learner will be able to identify the datatypes, variables and operators to be used to solve the problem and use tools like Devcpp to validate the result. (P.I. - 2.1.2, P.I. - 2.2.3, P.I.-5.3.2)*	
02.	**Control Structures in C** ***Learning Objective:*** *Learner is expected to recall basics of Control Structures and understand Conditional structures. Also expected to apply it to solve problems in C.* **Contents:** Branching - If statement, If-else Statement, Multiway decision. Looping – while, do-while, for Nested control structure- Switch statement, Continue statement, Break statement, Goto statement. Logic building exercise on branching and looping statements. **Task 3:** C Program to compare two numbers and determine whether they are odd or even. *LO 2.1: A learner will be able to identify the variables, datatypes and use if else branching statement to solve the problem and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.3, P.I.-5.3.2)* **Task 4:** C Program to find percentage marks of four subjects. Then determine whether the student has secured distinction, first class, second class or fail. Percentage >=75 Distinction, Percentage >= 60 First class, Percentage >= 40 second class etc. *LO 2.2: A learner will be able to identify the variables, datatypes and use else-if-else branching statement to solve the problem and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.3, P.I.-5.3.2)* **Task 5:** C Program to print numbers between 1 and 100 which are multiples of 5 by using do while loop. *LO 2.3: A learner will be able to identify the variables, datatypes and use for looping statement to solve the problem and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.3, P.I.-5.3.2)*	**16**
03.	**Functions in C** ***Learning Objective:*** *Learner is expected to recall function definition, declaration. and understand its usage. Also expected to apply it to solve problems in C.* **Contents:** Function -Introduction of Function, Function Main, Defining a Function, Accessing a Function, Function Prototype, Passing Arguments to a Function, Recursion. Storage Classes and its types. Logic building exercise on user defined functions. **Task 6:** C Program to create a user defined function with arguments and no return value for addition of two numbers. *LO 3.1: A learner will be able to identify the variables, datatypes and use function with arguments and no return value to solve the problem and use Devcpp*	**12**

	to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.3, P.I.-5.3.2) **Task 7:** C Program to find Fibonacci series for given no of elements using recursive function. *LO 3.2: A learner will be able to identify the variables, datatypes and reframe the problem to use recursive function to get the solution and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.1, P.I.- 5.3.2)*	
04.	***Arrays, Strings in C*** ***Learning Objectives:*** *Learner is expected to recall one dimensional arrays and understand its usage and apply it to solve problems in C.* **Contents:** Array-Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array. String- Basic of String, Array of String, Functions in string.h. Logic building exercise on arrays and strings. **Task 8:** C Program to sort elements in ascending order in an array. *LO 4.1: A learner will be able to identify the variables, datatypes and reframe the problem to use arrays to get the solution and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.1, P.I.- 5.3.2)* **Task 9:** C Program to check if string is palindrome or not. *LO 4.2: A learner will be able to identify the variables, datatypes and reframe the problem to use strings to get the solution and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.1, P.I.- 5.3.2)*	**12**
05.	**Structures and Pointers in C** ***Learning Objective/s:*** *Learner is expected to recall pointers, operations on pointers and its usage and apply it to solve problems in C.* **Contents:** Structure- Declaration, Initialization, structure within structure, Operation on structures, Array of Structure. Pointer: Introduction, Definition and uses of Pointers, Address Operator, Pointer Variables, Pointer Arithmetic, Pointers to Pointers, Pointers and Array, Passing Arrays to Function, Pointers and Function, Pointers and two-dimensional Array, Array of Pointers, Dynamic Memory Allocation. Logic building exercise on pointers. **Task 10:** C Program to create a structure to enter details for 5 students. The details are name, branch, roll no and marks of five different subjects. Also calculate the total marks and arrange them in ascending order. *LO 5.1: A learner will be able to identify the variables, datatypes and reframe the problem to use structure to get the solution and adapt and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I. - 2.2.1, P.I.- 5.1.2, P.I.- 5.3.2)* **Task 11:** C Program to create, initialize, assign and access a pointer variable. *LO 5.2: A learner will be able to identify the variables and use pointer to get the solution and adapt and use Devcpp to validate the result. (P.I. - 1.3.1, P.I. - 2.1.2, P.I.- 5.1.2, P.I.- 5.3.2)* **Task 12:** C Program to demonstrate dynamic memory allocation *LO 5.3: A learner will be able to identify the variables, datatypes and use pointer to get the solution, adapt and use Devcpp to validate the result and identify new updates like dynamic memory management in C for writing efficient programs (P.I. - 1.3.1, P.I. - 2.1.2, P.I.- 5.1.2, P.I.- 5.3.2, P.I- 11.1.1 P.I- 11.2.1)*	**12**
	Course Conclusion	

		01
	Total	**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems.
1.3.1	Apply engineering fundamentals.
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.2.1	Reframe the computer-based system into interconnected subsystems
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use
11.1.1	Describe the rationale for the requirement for continuing professional development
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

Course Outcomes: A learner will be able to -

1. Implement the basic terminology used in computer programming concept of data types, variables and operators using C. (*LO 1.1, LO 1.2*)
2. Use control structure concepts in C programming (*LO 2.1, LO 2.2, LO2.3*)
3. Develop functions and use it to solve problems in C using modern tools. (*LO 3.1, LO 3.2*)
4. Apply arrays and strings to solve problems in C. (*LO 4.1, LO 4.2*)
5. Demonstrate the use of structures, dynamic memory allocation and pointers in C. (*LO 5.1, LO 5.2, LO 5.3*)

CO-PO Mapping Table with Correlation Level

CO ID	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
ESL103.1	3	3			3						
ESL103.2	3	3			3						
ESL103.3	3	3			3						
ESL103.4	3	3			3						
ESL103.5	3	3			3						3
Average	3	3			3						3

Text Books :

1. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
2. Programming with C, Byron S. Gottfried, Fourth Edition, 2018, Tata McGraw-Hill Publications.
3. Programming in ANSI C, E. Balaguruswamy, Eighth edition, 2019, Tata McGraw-Hill Publications.

Reference Books :

1. Programming in C, Pradeep Day and Manas Gosh, Second Edition, 2013, Oxford University Press.
2. Let Us C: Authentic Guide to C Programming Language, Yashwant Kanetkar, Nineteenth Edition, 2023, BPB Publication.

Other Resources :

1. NPTEL Course: Introduction to Programming in C By Prof. Satyadev Nandakumar, Department of Computer Science and Engineering, IIT Kanpur
   Web link- https://archive.nptel.ac.in/courses/106/104/106104128/
2. Problem Solving through Programming in C By Prof. Anupam Basu, Department of Computer Science and Engineering Engineering, IIT Kharagpur
   Web link- https://archive.nptel.ac.in/courses/106/105/106105171/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Task Execution (30 Marks)

Students will be given minimum 12 tasks.

Students are expected to

1. Identify variables, data types methods/approach required to write the code for the given task and apply the same.
2. Gain knowledge of Operators, data input and output concept
3. Recall basics of control structures and apply it to solve problems in C.
4. Execute given task for different inputs and verify the result
5. Execute the function and integrate the functions for task completion.
6. Create a 1D, 2D array to solve problem.
7. Apply structure concept to solve the problem.
8. Apply concept of pointers to solve the problem.

Students will be evaluated based on following:

1. Logic building for the given task (10 marks)
2. Rectifying logical errors and syntax errors (06 marks)
3. Well-structured and organized program (06 marks)
4. Verification of experiment output for different inputs (08 marks)

Refer the sample task given below.

Example: Write a menu driven C program to perform different calculations using function,

Students are expected to,

1. Identify variables, data types and functions to be used in the program.
2. Execute given task for different inputs and verify the result
3. Follow the coding standards
4. Identify errors and rectify the errors.

2. Regularity and active participation: (05 Marks)

3. Practical Test (15 Marks)

a) Task Execution: 10 Marks

1. Logic building for the given task (04marks)
2. Rectifying logical errors and syntax errors (02 marks)
3. Well-structured and organized program (02 marks)
4. Verification of experiment output for different inputs (02 marks)

b) Oral: 05 Marks

END SEMESTER EXAMINATION (Practical & Oral Exam) (50 Marks)

1. Task Execution: 15 Marks

   Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned in continuous evaluation
2. Presentation of Results and conclusion, Inferences drawn: 05 Marks
3. Multiple Choice Questions based on entire syllabus: 15 Marks
4. Oral based on entire syllabus: 15 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
SEC	SEC101	BASIC WORKSHOP PRACTICE I	01

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
50	--	50

Pre-requisite :

There are no specific prerequisites for this course. However, students should have a willingness to learn and a commitment to safety.

Program Outcomes addressed :

1. PO1:Engineering knowledge
2. PO5: Engineering tool usage
3. PO6: The engineer and the world
4. PO8: Individual and collaborative team work
5. PO11: Life-long learning

Course Objectives :

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labour.
3. To get exposure to interdisciplinary engineering domain.

Module	Details	Hrs
	Course Introduction The Basic Workshop Practice I course is intended to give participants with the core information and abilities required for working safely and effectively in a workshop environment. This hands-on course introduces the fundamental principles, equipment, and techniques utilised in a variety of workshop scenarios, such as fitting, hardware and networking, and welding.	**01**
01.	***Learning Objectives:*** *1. To familiarize participants with reading and interpreting technical drawings, and schematics related to fitting tasks.* *2. To enhance participants' proficiency in fitting various components or materials together accurately and securely using various fitting tools.* *3. To make participants learn to use precision measuring tools to verify part dimensions and ensure quality control.*	**09**
	Content: Fitting • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations: filing to size, one simple male- female joint, drilling and tapping.	
	Learning Outcomes : *A learner will be able to* *LO1.1: Read and interpret technical drawings, or schematics related to fitting tasks, identifying dimensions, tolerances, and other specifications accurately. (P.I.-1.3.1, 11.3.1)*	

	LO1.2: Demonstrate proficiency in fitting techniques. (P.I.- 5.3.1) *LO1.3: Competent in the effective use of precision measuring tools to examine work pieces, confirm dimensions, and ensure adherence to quality requirements and standards. (P.I.- 1.4.1, 5.2.2, 11.3.1, 11.3.2)*	
02.	***Learning Objectives:*** *1. To gain a comprehensive understanding of computer hardware components and peripheral devices.* *2. To learn how to assemble a computer system, set up and configure network infrastructure components, including routers, switches, access points, and cables, to create a functional network environment.* *3. To develop the skills to diagnose and troubleshoot common hardware and network problems.*	**10**
	Content: Hardware and Networking • Dismantling of a Personal Computer (PC), Identification of components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives, etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one). • Basic troubleshooting and maintenance. • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping.	
	Learning Outcomes : *A learner will be able to* *LO2.1: Identify and understand the various hardware components of a computer system. (P.I.- 5.1.2, 11.1.1)* *LO2.2: Assemble a computer system, set up and configure network infrastructure components to create a functional network environment. (P.I.- 1.2.1, 5.2.2, 11.2.1)* *LO2.3: Develop the skills to diagnose and troubleshoot common hardware and network problems. (P.I.- 1.3.1, 6.1.1, 6.3.1)*	
03.	***Learning Objectives:*** *1. To understand welding symbols and their meanings as per standard welding blueprints. Interpret welding drawings and specifications accurately.* *2. To become familiar with welding equipment, including welding machines, electrodes, torches, gas cylinders, filler metals, and other tools. Learn how to set up and operate welding equipment safely and efficiently.* *3. To develop proficiency in various welding techniques such as lap welding, butt welding, fillet welding, and groove welding. Practice achieving proper weld bead geometry, penetration and fusion.*	**08**
	Content: Welding • Introduction to welding equipment. Edge preparation for welding jobs. Arc welding for different job like, lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles. One job on gas welding.	

	Learning Outcomes : *A learner will be able to* *LO3.1: Interpret welding symbols and blueprints accurately, understanding weld joint designs, dimensions, and specifications as per industry standards. (P.I.- 8.3.1, 11.3.1)* *LO3.2: Produce welds that meet industry standards and specifications, demonstrating the ability to achieve proper weld penetration, fusion, and surface finish while minimizing defects such as porosity, lack of fusion, and undercutting. (P.I.- 1.3.1, 1.4.1, 5.2.2, 5.3.1, 6.1.1, 6.3.1, 8.1.1, 11.3.2)*	
04.	***Learning Objectives:*** *1. To gain knowledge of the different parts of a lathe machine, including the bed, headstock, tailstock, carriage, tool post, chuck, and various controls.* *2. To gain an understanding of lathe operations such as turning between centers, chucking, facing, taper turning, and threading. Understand the sequence of operations and the appropriate use of cutting tools and feeds for each operation.*	**02**
	Content: Machine Shop • Machine Shop (Demo of one simple lathe job) (Only for Mechanical Engineering students, other department students can utilized this time to complete the pending work, if any).	
	Learning Outcomes : *A learner will be able to* *LO4.1: Identify different parts of a lathe machine and understand operations that can be carried out on it. (P.I.- 11.1.1, 11.3.1)*	

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply Mechanical engineering concepts to solve engineering problems.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
5.3.1	Discuss limitations and validate tools, techniques and resources.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
11.1.1	Describe the rationale for the requirement for continuing professional development.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.
11.3.1	Source and comprehend technical literature and other credible sources of information.

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to

1. Develop the necessary skill required to handle/use different fitting tools. (*LO 1.1, LO 1.2, LO 1.3*)
2. Develop skill required for hardware maintenance and installation of operating system. (*LO 2.1, LO 2.2, LO 2.3*)
3. Identify the network components and perform basic networking and crimping. (*LO 2.1, LO 2.2, LO 2.3*)
4. Prepare the edges of jobs and do simple arc welding. (*LO 3.1, LO 3.2*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
SEC101.1	3				3						3
SEC101.2	3				3	3					3
SEC101.3	3				3	3					3
SEC101.4	3				3	3		3			3
Average	3				3	3		3			3

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Continuous Internal Assessment (CIA) - (50 Marks)

Job Work with complete workshop book : 40 Marks

Attendance and Active participation : 10 marks

Course Type	Course Code	Course Name	Credits
BSC	BSC204	ENGINEERING MATHEMATICS-II	04

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. Differentiation of several variable I & II
2. Integration
3. Beta and Gamma Function

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO8: Individual and Collaborative Teamwork
4. PO 11: Life Long Learning

Course Objectives:

1. To provide the Basic knowledge of the concepts of Mathematics applicable to the field of engineering.
2. To build a mathematical foundation of the methodology required for solving application based problems in the field of Engineering.

Module	Detailed Contents	Hrs
00.	Mathematics is the fundamental step which creates a solid foundation for all Applied fields of Engineering. Professional Engineering applications have Mathematics as an integral part of their evolution. For example: Formulation in Mathematics to various engineering field using case study. Introduction to differential equations from Electrical circuit. Introduction to Multiple Integration from real life application. Hence, Formulation Based Mathematics is a fundamental requisite to all fields of Engineering for analyzing their performances.	**01**
01.	**Differential Equations of First Order and First Degree** ***Learning Objective/s:*** *Learner will be able to* *1. Analysis and interpretation of the basic fundamentals of differential equations (D.E) of first order & first degree.* *2. Determination of the solution of a first order D.E by applying the basic concepts of exact and linear DE.*	**08-10**

	Contents: Definition, Formation of Differential equation, Exact differential Equations, Non Exact Differential Equation, Integrating Factors, Rules for finding the integrating factor, Linear Differential Equations, Equation reducible to Linear form , Bernoulli's equation.	
	Self-Learning Topics: *Application of differential equations of First Order and First Degree in electrical circuits and thermodynamics.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1 : Apply the differential techniques to identify and classify different differential equations including exact, linear and Bernoulli's equation. (PI;1.1.1, PI: 11.1.3)* *LO 1.2 : Identify whether the given differential equation is exact and linear DE. (PI: 2.1.3).* *LO 1.3: Identify the process of reducing given DE into linear DE and solve it. (PI: 2.2.3).* *LO 1.4 : Apply the fundamental engineering concepts to model a first order DE and demonstrate solution process and results within a team .(PI; 1.3.1 , PI: 8.2.1)* *LO 1.5) : Engage in a team-based project where members individually contribute to different aspects of solving and interpreting a first-order differential equation derived from a given engineering problem, culminating in a coordinated group presentation.(PI: 8.3.1)* *LO 1.6: Identify the differential equation and recognize how advancements in engineering applications (such as control systems, fluid mechanics, and electrical circuits) historically required continuous learning in differential equation methods to stay current with technological innovations.(PI: 11.2.1)*	
02.	**Linear Differential Equations with Constant Coefficients of Higher Order type f(D)y = X** ***Learning Objective:*** *Learner will be able to* 1. *Analysis and interpretation of the basic fundamentals of higher order differential equations (HODE).* 2. *Determination of the solution of a HODE by applying the basic concepts of complementary function and particular integral.*	**12-14**
	Contents: **Complementary Function, Particular Integral, Type 1. X = e^{ax} , Type 2 X = x^n ,Type 3 X = $cos(ax+b) or\ sin(ax+b)$,Type 4 X = $e^{ax}V$** **Type 5 X = xV, General Type - Method of variation of parameters**	

	Self-Learning Topics: 1. *Differential equations with Variable Coefficients* 2. *(Cauchy's and Legendre's Linear Differential Equations)* 3. *Applications of Higher Order Linear Differential Equations to develop a mathematical model of linear differential equations.* ***Learning Outcomes:*** *LO 2,1: Identify the correct type of non-homogeneous term (e.g., exponential, polynomial, trigonometric) and select the appropriate solution method. (PI :2.2.3)* *LO 2.2: Apply the method of variation of parameters to solve nonhomogeneous second-order differential equations. (PI: 1.1.1)* *LO 2.3: Identify the appropriate method to determine the complementary function and particular integral for getting the general solution of HODE.(PI: 2.1.3)* *LO 2.4: Apply the appropriate method to determine the general solution of HODE.(PI: 1.2.1)*	
03.	**Double Integration in Cartesian coordinate** ***Learning Objectives:*** 1. *Analysis of the fundamentals of Double integration in different coordinate systems (Cartesian and polar) and apply it to solve problem.* 2. *Application of the concepts of double integrations to evaluate area and mass of the Lamina* **Contents:** **Tracing of standard curve** **Definition, Evaluation of Double Integrals,** **Change the order of integration, Evaluation of double integrals by changing the order of Integration, Evaluation of integrals over the given region.** ***Self-Learning Topics:*** Double integration in Elliptical polar coordinate **Learning Outcomes**: *A learner will be able to* *LO 3.1: Compare the efficiency of solving double integrals by direct evaluation versus changing the order of integration and select the best one to solve the given problem.. (P.I.-2.2.4)* *LO 3.2: Reframe a complex region of integration into sub-regions to simplify the evaluation of a double integral. (P.I.-2.2.1).* *LO 3.3: Apply the fundamentals of integration of a function of single variable to solve problem in double integration in Cartesian coordinate system. (P.I.-1.1.1)* *LO 3.4: Apply the appropriate method to evaluate a double integral in Cartesian coordinate system by using the law of integration. (PI :1.2.1)* *LO 3.6: Identify the need of double integration in Cartesian coordinates and utilise the relevant concepts to solve real-world problems like heat transfer in thermal systems, fluid flow in pipelines, and electrical potential in electromagnetic fields.(PI: 11.1.3)* *LO 3.7: Analyze and state the need of how staying updated with current double integral in Cartesian coordinates-based computational tools and methods contributes to lifelong learning and enhances problem-solving skills in professional engineering practice. (P I 11.2.1)*	**13-15**
04.	**Double Integration in Polar coordinate** ***Learning Objective/s:***	**10-12**

	1. *Analysis of the fundamentals of Triple integration in different coordinate systems and application of it to solve problem.* 2. *Application of the concepts of triple integrations to evaluate volume of a solid.*	
	Content: **Tracing of standard curve(Polar)** **Evaluation, Evaluation of double integrals by changing to polar Co-ordinates, Evaluation of integrals over the given region.** **Application of double integrals to compute Area, Mass of a lamina.**	
	Self-Learning Topics: Moment of inertia of a plane lamina	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the fundamentals of integration of a function of single variable to solve problem in double integration in polar coordinate system. (P.I.-1.1.1)* *LO 4.2: Apply the knowledge of Jacobian when changing from Cartesian to polar coordinates in order to evaluate a double integrals.(PI: 1.2.1)* *LO 4.3: Compare the efficiency of solving double integrals by direct evaluation versus changing into polar coordinate system of integration and select the best one to solve the given problem.. (P.I.-2.2.4)* *LO 4.4: Reframe a complex region of integration into sub-regions to simplify the evaluation of a double integral in polar coordinate system.. (P.I.-2.2.1).* *LO 4.5: Lead a group project or presentation on the applications of double integrals (area and Mass of Lamina) by demonstrating problem solving and analytical thinking,. (PI: 8.2.1)* *LO 4.6: Collaborate in teams to present solution involving area under curves and mass of a Lamina using double integral, showcasing effective communication and individual contribution. (PI: 8.3.1)*	
05.	**Triple integration** ***Learning Objective/s:*** 1. *Analysis of the fundamentals of Triple integration in different coordinate systems and apply it to solve problem.* 2. *Application of the concepts of triple integrations to evaluate volume of a solid.*	**9-11**
	Contents: **Definition, Evaluation of Triple Integral using Cartesian coordinates, Evaluation of Triple Integral using cylindrical coordinates, Evaluation of Triple Integral using Spherical coordinates.** **Application of triple integrals to compute Volume and Mass of solid.**	
	Self-Learning Topics: Moment of inertia of a solid.	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply the fundamentals of integration of a function of single variable to solve problem in triple integration in different coordinate system. (P.I.:1.1.1)* *LO 5.2: Apply the knowledge of Jacobian when changing from Cartesian to spherical polar and cylindrical polar coordinates in order to evaluate a triple integrals(PI: 1.2.1)*	

	LO 5.3 : *Compare alternative integration approaches (evaluation in different coordinate systems) and select the optimal solution path to evaluate the integral.(PI 2.2.4)* *LO 5.4: Identify the appropriate mathematical knowledge of triple integrals and different coordinate systems needed to solve problems involving three-dimensional solids.(PI: 2.1.3)*	
06.	**Numerical solution of ordinary differential equations of first order and first degree** ***Learning Objective/s:*** *Application of the concepts of numerical methods to solve the ordinary differential equation.*	**9-11**
	Contents: Numerical solution of ordinary differential equation using (a) Taylor's series method (b) Euler 's method (c) Modified Euler method, (d) Runge-Kutta fourth order method	
	Learning Outcomes: *The learner will be able to* *LO 6.1: Identify numerical methods such as Taylor's series method, Euler's method, modified Euler's method and R K method of fourth order for solving ODE.(PI: 2.1.3)* *LO 6.2: Identify appropriate process based on the type of the given differential equation for solving the DE numerically.. (PI: 2.2.3)* *LO 6.3: Apply appropriate method to solve the differential equation numerically.(PI : 1.1.1)* *LO 6.4**:** Apply engineering systems such as electrical circuits, mechanical vibrations, or fluid flow to formulate the ODE and solve it numerically.(PI: 1.3.1)* *LO 6.5: Compare analytical and numerical solutions for the same differential equation* ***and*** *evaluate accuracy.(PI: 2.2.4)*	
	Course Conclusion	**01**
Total		**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques as calculus/algebra to solve problems.
1.2.1	Apply laws of natural science to a mathematical problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problem.
2.1.1	Articulate problem statements and identify objectives.
2.1.3	Identify the mathematical knowledge that applies to a given problem.
2.2.1	Reframe complex problems into interconnected sub-problems
2.2.3	Identify existing processes/solution methods for solving the Problems.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3.1	Combine mathematical principles and engineering concepts to formulate mathematical models of an engineering problem.
8.2.1	Demonstrate effective communication, problem solving, and conflict resolution and leadership skills.
8.3.1	Present result as a team, with smooth integration of contributions from all individual efforts.
11.1.3	Identify various mathematical concepts/theorems which can be utilised in the field of application based engineering.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

Course Outcomes:

A learner will be able to

1. Apply the fundamentals of first order Differential equation to analyze an Exact , Linear DE and solve it by applying the appropriate method (*LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5, LO 1.6*)
2. Implement the fundamentals of Higher order DE to analyse the procedure to find complementary function and particular integral of higher order differential equation in order to evaluate the general solution.*(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Apply the fundamentals of double integration to analyse and evaluate the area and mass of a lamina. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6, LO 3.7,LO 4.1 , LO 4.2, LO 4.3, LO 4.4, LO 4.5 , LO 4.6)*
4. Apply the fundamentals of triple integration to analyse and evaluate the volume and mass of a solid. *(LO 5.1 , LO 5.2, LO 5.3, LO 5.4)*
5. Implement the fundamentals of numerical methods to solve ordinary differential equation.(*LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC204.1	3	3	--	--	--	--	--	3	--	--	3
BSC204.2	3	3	--	--	--	--	--	--	--	--	--
BSC204.3	3	3	--	--	--	--	--	3	--	--	3
BSC204.4	3	3	--	--	--	--	--	--	--	--	--
BSC204.5	3	3	--	--	--	--	--	--	--	--	--
Average	3	3	--	--	--	--	--	3	--	--	3

Text Books :

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, forty fourth Edition, 2021
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, Tenth Edition, 2011.
3. Advanced Engineering Mathematics, H.K.Das, S. Chand and Company Limited, Fourth Edition, 2018.

Reference Books:

1. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press, First Edition, 2015
2. Engineering Mathematics by P. Sivaramakrishna Das and C. Vijayakumari, Pearson, First Edition, 2017
3. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill,2017

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

a. One MCQ Test + One Class Test: 05+05 = 10 Marks

b. One Team Pair Solo (TPS) activity: 05 Marks

c. Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
BSC	BSC205	ENGINEERING PHYSICS-II	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World

Course Objectives:

1. To provide the Basic knowledge on the concepts of physics pertaining to the field of engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of physics in the field of engineering.

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Crystal Structure** ***Learning Objective:*** • *To provide the fundamental knowledge of crystal structures.* • *To study the unit cell characteristics of a simple cubic structure .*	**3-5**
	Contents: Crystals: Unit cell: Space lattice, Basis and Crystal structure: Cubic Structures (SC, BCC and FCC): Unit cell characteristics for simple cubic: Unit cell volume, Number of atoms per unit cell, Coordination number, Atomic radius, Nearest neighbour distance, Packing fraction, Percentage of void space and Density.	
	Self-Learning Topics: *Crystals: Lattice parameters.*	

	Learning Outcomes: *A learner will be able to* *LO1.1: apply the knowledge of Lattice parameters of unit cell of a crystal to identify crystal structures. (P.I.- 1.2.1)* *LO1.2: apply the knowledge of unit cell characteristics to solve problems. (P.I.1.3.1)* *LO1.3: identify various parameters to study simple cubic structure. (P.I.- 2.1.2)* *LO 1.4: identify the mathematical process to derive the unit cell characteristics of a simple cubic structure. (P.I.- 2.1.3)*	
02.	**Analysis of Crystal Structure** ***Learning Objective:*** • *To familiarize the concept of Miller Indices to represent the crystal planes.* • *To provide the knowledge of X-ray diffraction in analysis of crystal structure.*	**4-6**
	Contents: Crystal planes and Miller indices; Interplanar spacing: Relation between interplanar spacing and Miller indices for cubic unit cell. Diffraction of X-ray and Bragg's law; Bragg's spectrometer: Principle, Construction and working; Determination of crystal structure using Bragg's spectrometer.	
	Self-Learning Topics: - *Crystals: Lattice parameters.*	
	Learning Outcomes: *A learner will be able to* *LO2.1: apply the knowledge of miller indices to identify various planes in a crystal. (P.I.- 1.2.1)* *LO2.2: Additional: apply the knowledge of X-rays and diffraction in analysis of crystal structure. (P.I.- 1.3.1)* *LO2.3: apply the knowledge of miller indices, crystal planes and Bragg's law to solve the problems. (P.I.- 1.3.1)* *LO2.4: identify the mathematical process and knowledge of miller indices to derive the interplanar distance in a simple cubic structure (P.I.- 2.1.3)* *LO2.5: identify the mathematical process and knowledge of crystal planes to derive Bragg's law. (P.I.- 2.1.3)* *LO2.6: identify physical phenomena, components and process to analyse the crystal structure by using Bragg's spectrometer. (P.I.- 2.2.3)*	
03.	**Non-Crystalline Materials**	**3-5**
	Learning Objective: • *To gain the basic knowledge of non-crystalline solids.* • *To recognize the solids with amorphous structure and their importance in various applications.*	
	Contents:	

	Structure: order and disorder, importance of short range order, properties of non-crystalline solid; Classes: metals/metalloid glasses, alloys of transitions metals with rare earth atoms. Silica glasses and related alloys.	
	Self-Learning Topics: Application of non-crystalline materials.	
	Learning Outcomes: *A learner will be able to* *LO3.1: apply the knowledge of various models to interpret the structure of non-crystalline material. (P.I.- 1.2.1)* *LO3.2: apply the knowledge of order and disorder to study the properties of non-crystalline material and differentiate them from crystalline material. (P.I.- 2.1.2)* *LO3.3: identify the component elements to differentiate the types of non-crystalline solids and their application. (P.I.- 2.1.2)*	
04.	**Magnetic and Dielectric Materials**	**6-8**
	Learning Objectives: • *To explore the properties of magnetic and dielectric materials.* • *To enhance the knowledge of magnetic and dielectric materials for practical applications.*	
	Contents: Magnetic materials: Ferromagnetism: Magnetization of ferromagnetic materials, hysteresis loop: soft and hard magnetic materials, Magnetoresistive materials, Applications of magnetic materials. Dielectric materials: Dielectric materials: Dielectric constant; Dielecctric polarization; Dielectric susceptibility; Dipoles; Nonpolar and polar dielectric, Applications of dielectric materials.	
	Self-Learning Topics: *Magnetization of materials.*	
	Learning Outcomes: *A learner will be able to* *LO4.1: apply the knowledge of physics of materials to study the magnetic and dielectric materials (P.I.- 1.2.1).* *LO4.2: apply the concept of magnetic and dielectric phenomena in materials to solve the problems. (P.I.- 1.3.1)* *LO4.3: identify various parameters to differentiate types of ferromagnetic materials and dielectric materials (P.I.- 2.1.2)* *LO4.4: identify the method to analyze the variation of magnetic flux density with magnetizing force in ferromagnetic materials. (P.I.-2.2.3)* *LO4.5: identify the applications of magnetic materials and dielectric materials to meet the public need. (P.I.- 6.1.1)* *LO4.6: identify the impact of retentivity and coercivity in soft and hard magnetic materials. (P.I.-6.1.2)*	

05.	**Nanomaterials** ***Learning Objective/s:*** • *To explore the basics of nanomaterials.* • *To recognize the applications of nanomaterials in current technology.*	**3-5**
	Contents: Introduction; Properties (Optical, electrical, magnetic, mechanical); Surface to volume ratio; Two main approaches in nanotechnology to synthesize Nanomaterials (Bottom up technique and Top down technique); Synthesis methods: Ball milling; Chemical vapour deposition; Applications.	
	Self-Learning Topics : *Advantages and disadvantages of Ball milling and Chemical vapour deposition methods*	
	Learning Outcomes : *A learner will be able to* *LO5.1: apply the knowledge of physics of materials to study the properties and applications of nanomaterials. (P.I.- 1.2.1)* *LO5.2. apply the concept of surface area to volume ratio in nanomaterials to solve the problems. (P.I.- 1.3.1)* *LO5.3: identify top-down and bottom-up approaches to classify various synthesis methods of nanomaterials. (P.I.2.1.2).* *LO5.4: identify the components, process in various methods for the preparation of different nanomaterials. (P.I.-2.2.3)*	
06.	**Characterization Techniques of Nanomaterials**	**3-5**
	Learning Objective/s: • *To familiarize the tools for specific characterization of nanomaterials.*	
	Contents: Tools for characterization of Nanomaterials: Scanning Electron Microscope (SEM): Principle, construction, working and application; Transmission Electron Microscope (TEM): Principle, construction, working and application; Atomic Force Microscope (AFM) Principle, construction, working and application.	
	Self-Learning Topics: *Difference between optical and electron microscope*	
	Learning Outcomes: *A learner will be able to* *LO6.1: apply the knowledge of propagation of electrons to construct electron microscope. (P.I.1.3.1)* *LO6.2: identify the components, process and the physical phenomena involved in different characterizing tools (SEM, TEM and AFM) of nanomaterials. (P.I.-2.2.3)* *LO 6.3: identify the resolution of a device using light and electron beam to differentiate optical and electron microscope (P.I.2.1.2)*	

	LO6.4: identify the application of SEM, TEM and AFM for public use. (P.I.- 6.1.1) *LO6.5: identify the impact environmental conditions which affect life cycles of SEM and TEM. (P.I.-6.1.2)*	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
1.2.1	Apply laws of physics to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
6.1.1	Identify and describe various role of science particularly as pertains to protection of the public and public interest at global, regional and local level.
6.2.2	Interpret and explain the limitations in the usage of devices for protection of the public.

Course Outcomes:
A learner will be able to -

1. Learner will be able to apply the knowledge of various parameters to study crystalline and non-crystalline solids.
   (*LO1.1, LO1.2, LO1.3, LO1.4, LO3.1, LO3.2, LO3.3*)
2. Learner will be able to apply the fundamental knowledge of x-ray diffraction to analyse crystal structure (*LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6)*
3. Learner will be able to apply the fundamental knowledge of magnetic and dielectric materials in various technical fields by analyzing their intrinsic behaviours.
   (*LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6)*
4. Learner will be able to use the basic knowledge of nanomaterials and their characterization techniques to identify their applications in societal issues.
   (*LO 5.1, LO 5.2, LO 5.3, LO 5.4,, LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO6.5*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC205.1	3	3									
BSC205.2	3	3									
BSC205.3	3	3				3					
BSC205.4	3	3				3					
Average	3	3				3					

Text Books :

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

Reference Books :

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
3. The Physics of Amorphous Solids, Richard Zallen, Wiley - VCH
4. Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1st Edition, Wiley- Interscience.
5. Nano: The essentials: Understanding Nanoscience and Nanotechnology, T Pradeep, 1 st Edition, 2017, McGraw Hill.

Other Resources :

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.edu
3. Theory of the structure of Non-Crystalline Solids, Conference Review Paper, Int. conf. on
4. Theory of the structure of Non-Crystalline Solids. Jozef Bicerano et al.
5. NPTEL Course: Nano structured materials-synthesis, properties, self-assembly and applications by Prof. A. K. Ganguli, IIT Delhi:- Web linkhttps://nptel.ac.in/courses/118102003.

IN-SEMESTER ASSESSMENT (35 MARKS)

Continuous Assessment - Theory-(15 Marks)

1. MCQ test: 4 marks
2. Class test: 4 marks
3. Open book test/Open notes test: 4 marks
4. Regularity and active participation: 3 marks

Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

END SEMESTER EXAMINATION (40 MARKS)

End semester will be based on the syllabus coverage upto Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
BSC	BSC206	ENGINEERING CHEMISTRY- II	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Pre-requisite: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6 -The engineer and the world

Course Objectives:

1. To enable the students to apply the laws of chemistry to an engineering problem.
2. To enable the students to appreciate material properties and their engineering applications.
3. To enable the students to analyse and select the most appropriate engineering material.
4. To study the current developments in the field of nanotechnology, energy storage systemsand green chemistry for sustainable development.

Module	Details	Hrs.
	Course Introduction This course provides the insights into the properties, composition and behavior of materials and enables engineers to understand how differentmaterials react under various conditions, allowing them to select appropriate materials for specific applications.	**01**
01.	**Alloys** ***Learning Objective:*** *To classify the different types of alloys and interpret their properties and applications in industry and to comprehend the concept of powder metallurgy.*	**4-6**
	Contents: Introduction, Significance of alloying, Ferrous Alloys-classification, Plain carbonsteels and special steels: - Role of special elements in alloy steels. Shape memory alloys: definition, properties and uses.	

	Powder metallurgy – introduction, methods of metal powder production:- atomization, compacting by cold powder extrusion, sintering and its applications. Self-Learning Topics: *Applications of ferrous alloys in various industries. Applications of powder metallurg.* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1 Identify the significance of alloying in enhancing the properties of metals. (2.2.3)* *LO-1.2 Apply the knowledge of different types of ferrous alloys in improving the quality of materials used in engineering industry. (1.3.1)* *LO- 1.3 Identify the role of Carbon and special elements in improving the properties of plain carbon steels and alloy steels. (2.1.3)* *LO- 1.4 Apply the concept of shape memory effect to the specified alloys for solving the real life as well as industrial problems (1.3.1)* *LO- 1.5 Apply the knowledge of shape memory alloys in various fields for the societal benefits. (6.1.1)* *LO- 1.6 Identify the steps in powder metallurgy for improving the quality of metallic tools and equipment used in industries.(2.2.3)*	
02.	**Polymers** *Learning Objective: To use the knowledge of synthesis, properties and uses of various polymers in industry. This will aid in identifying the impact of disposal of plastics on general health and the environment.* **Contents:** Preparation, properties and uses of Phenol formaldehyde, PMMA, Kevlar. Effect of heat on the polymers (Glass transition temperature). Molecular weight of polymer and numericals. Conducting polymers and their applications. Electroluminescent polymer, Biodegradable polymers. ***Self-Learning Topics:*** *Classification of polymers, Thermoplastic and Thermosetting plastics.* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1 Apply fundamental engineering chemistry concepts to thermoplastic and thermosetting polymers. (1.3.1)* *LO -2.2 Identify the synthesis, reactions and properties of PMMA, Kevlar and Bakelite for industrial use.* (2.2.3) *LO-2.3 Apply the formulae for number and weight average molecular weight and polydispersity index for solving the numerical problems. (P.I.-1.2.2)* *LO-2.4 Identify the polymeric material for the protection of public health. (6.1.1)* *LO-2.5 Identify the factors affecting the glass transition temperature for deciding the utility of industrial polymers. (2.1.3)* *LO-2.6 Apply the knowledge of various types of conducting and electroluminescent polymers for improving the quality of industrial polymers. (1.3.1)*	**4-6**
03.	**Advanced Functional materials**	**4-6**

	Learning Objective: *To familiarize with the composite materials, their properties and applications in various industries and for the protection and safety of society.*	
	Contents: Introduction, Constitution- i) Matrix phase ii) Dispersed phase. Classification- (A) Particle - reinforced composites- i) Large – particle reinforced composites ii) Dispersion – strengthened composites. (B) Fiber – reinforced composites- i) Continuous – aligned ii) Discontinuous – aligned (short)- (a) aligned (b) randomly oriented (C) Structural Composites- i) Laminates (ii) Sandwich Panels. Their applications in aeronautical engineering and other industries.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO-3.1 Identify the properties of composites to analyse the materials used in engineering industry. (2.2.3)* *LO-3.2 Identify the role of constituents of composites for improving the quality of composite materials. (2.1.3)* *LO- 3.*3 Apply the knowledge of various types of composite materials and their properties for further advancement in automobile and aeronautical industries. *(P.I.-1.3.1)*	
04.	**Carbon Nanomaterials**	**3-5**
	Learning Objectives: *To use carbon nanomaterials on the basis of their mechanical and electrical properties in various industrial applications and modern devices.*	
	Contents: Introduction to nanomaterials, comparison between nanomaterials and their bulk counter parts. structure and properties of graphite as a precursor for carbon nanomaterials. structure, electrical and mechanical properties of Carbon Nanomaterials like graphene, CNTs and Fullerenes. Methods of preparation of carbon nanomaterials: Laser ablation method Application of Nanomaterials in various industries.	
	Self-Learning Topics: *Inorganic nanomaterials like metals, metal oxides etc.*	
	Learning Outcomes:	
	A learner will be able to *LO-4.1 Apply the fundamental engineering concepts to compare the properties of bulk materials with their respective nanomaterials to improve the quality of products in pharma, cosmetic and electrical industries. (1.3.1)* *LO-4.2 Identify the engineering chemistry concepts to analyze the structure as well as electrical and mechanical properties of carbon nanomaterials for their potential applications in engineering. (2.1.3)*	

	LO-4.3 Identify the methods of preparation of carbon nanomaterials to enhance their properties for the betterment of the quality of engineered products. (2.2.3)	
05.	**Batteries**	**4-6**
	Contents: Introduction and Characteristics of batteries. Construction, working and applications of Lithium-ion batteries, Hydrogen oxygen alkaline fuel cells. E-waste Management, Battery e-waste management.	
	Self-Learning Topics: *Classification of batteries.*	
	Learning Outcomes: *A learner will be able to* *LO-5.1 Identify the concepts of electrochemistry for analyzing the types of batteries. (2.1.3)* *LO-5.2 Apply the knowledge of electrochemistry in the construction and working of lithium-ion and fuel cell batteries for improving the efficiency of devices. (1.3.1)* *LO-5.3 Identify the existing battery technologies such as Li-ion and Fuel cell for solving real-world problems. (2.2.3)* *LO-5.4 Identify the impact of disposal of toxic components of batteries for the public safety.(6.1.1)* *LO-5.5 Analyse the e-waste recycling methods of batteries for their effect on sustainable development. (6.1.2)*	
06.	**Spectroscopic Techniques**	**3-5**
	Learning Objective/s: *To differentiate between the various ranges of electromagnetic spectrum used in the different types of spectroscopic techniques like absorption and emission spectroscopy*	
	Contents: Spectroscopy - Principle, atomic and molecular spectroscopy. Beer lambert's law and UV-Visible Spectroscopy, Selection rules. Introduction to fluorescence and phosphorescence, Jablonski diagram. Numericals based on Beer Lambert's Law.	
	Self-Learning Topics: *Electromagnetic radiation, characteristics of electromagneticradiation, electromagnetic spectrum.*	
	Learning Outcomes: *A learner will be able to* *LO-6.1 Identify a type of spectroscopic technique by analyzing the transitions occurring in a compound. (P.I.-2.1.3)* *LO-6.2 Identify the allowed and forbidden transitions from selection rules for feasibility of a spectroscopic technique. (2.2.3)* *LO-6.3. Apply the formulae based on Beer Lambert's law to calculate absorbance, concentration and molar extinction coefficient of given compounds. (1.2.2)* *LO-6.4 Identify the various radiative and non-radiative transitions occurring in a photo excited electron to analyze Jablonsky diagram for use in various spectroscopic techniques. (2.1.3)*	

	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem.
1.2.2	Apply the formulae based on the concepts of engineering chemistry for solving the numerical problems.
1.3.1	Apply fundamental engineering chemistry concepts to solve engineering problems.
2.1.3	Identify the engineering chemistry concepts to analyse the given problem
2.2.3	Identify the existing processes/ solution methods for solving the problems
6.1.1	Identify and describe the various roles of materials particularly as pertains to protection of the public and public interest at global, regional and local level
6.1.2	Analyse the environmental aspects of engineering problems for its impact on sustainability.

Course Outcomes: A learner will be able to -

1. Apply the concepts of engineering chemistry for solving the engineering problems (*LO-1.1, LO-1.2, LO-1.3, LO-1.4, LO-1.5, LO-1.6, LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-3.1, LO-3.2, LO-3.3, LO-4.1, LO-4.2, 4.3, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5, LO-6.1, LO-6.2, LO-6.3, LO-6.4)*
2. Analyse the quality and properties of engineering materials for solving real world problems. (*LO-1.1, LO-1.2, LO-1.3, LO-1.4, LO-1.5, LO-1.6, LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-3.1, LO-3.2, LO-3.3, LO-4.1, LO-4.2, 4.3, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5, LO-6.1, LO-6.2, LO-6.3, LO-6.4)*
3. Identify the suitable engineering material for the protection of the environment and public health. (*LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-3.1, LO-3.2, LO-3.3, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5,)*
4. Apply the knowledge of e-waste management and biodegradable polymers for the sustainable development. (*LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5,)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSC206.1	**3**	**3**				**3**					
BSC206.2	**3**	**3**				**3**					
BSC206.3	**3**	**3**				**3**					
BSC206.4	**3**	**3**				**3**					
Average	**3**	**3**				**3**					

Text Books :

1. A textbook of engineering chemistry by S. Dara, 2014 edition, Chand Publication.
2. Engineering Chemistry by Jain and Jain, 17th edition, 2018, Dhanpatrai publications.

Reference Books :

1. Engineering Chemistry by Jain and Jain, 17th edition, 2018, Dhanpatrai publications
2. Elements of 2017 by Y. R. Sharma, Spectroscopy 29th edition, Pragati Prakashan
3. Nano forms of carbon and its Applications by Prof Maheshwar Sharon and Dr. Madhuri Sharon, First edition, 2007, Monad nanotech Pvt Ltd

Other Resources :

1. Online chemistry library for open access text books: https://chem.libretexts.org

IN-SEMESTER ASSESSMENT (35 MARKS)

1. Continuous Assessment - Theory-(15 Marks)

1. Assignment on live problems: 8 marks
2. Poster making: 4 marks
3. Regularity and active participation: 3 marks

2. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (40 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
AEC	AEC 201	PROFESSIONAL COMMUNICATION & ETHICS-I	02+01

Examination Scheme					
Distribution of Marks			**Exam Duration (Hrs.)**		**Total Marks**
In-semester Assessment		**End Semester Examination (ESE)**			
Continuous Assessment	**Mid-Semester Exam (MSE)**		**MSE**	**ESE**	
50	--	--	--	--	50

Pre-requisite:

1. Keen desire to build confidence, develop language skills and reduce fear of public speaking
2. Intermediate knowledge of Spoken English
3. Intermediate level grasp of English Grammar and Vocabulary

Program Outcomes addressed:

1. PO 7: Ethics
2. PO 8: Individual and Collaborative Teamwork
3. PO 9: Communication
4. PO 11: Life-long learning

Course Objectives:

1. To demonstrate the fundamental concepts of interpersonal and professional communication.
2. To encourage active listening with focus on content, purpose, ideas and tone.
3. To facilitate fluent speaking skills in social, academic and professional situations.
4. To train in reading strategies for comprehending academic and business correspondence.
5. To promote effective writing skills in business, technology and academic arenas.
6. To inculcate confident personality traits along with grooming and social etiquettes.

Module	Details	Hrs.
	Course Introduction Every learning should lead toward the building of a holistic individual and a good citizen. Communication Skills and Ethics as a subject is the very fundamental requirement of a human being in any social and/or professional ecosystem. The syllabus has been compiled with the strategic idea of helping individual students to enhance, incorporate and implement the four pillars of Communication, Listening, Speaking, Reading and Writing (LSRW Skills), in all walks of life. There is an added emphasis on Ethical behavior and communication which is an integral value that every good human being, who also aims at being an impressive professional, should imbibe. The learner will also gain basic skills in professional writing and public speaking, exude confidence in presenting themselves and their work, with hands-on training in real time.	**01**

01.	***Fundamentals of Communication*** ***Learning Objective:*** *To aid the learner in understanding the importance of communication in the spoken and written form so that they can express themselves effectively and ethically in any professional or social setting.* *To encourage active listening with focus on content, purpose and ideas which can then be shared using ICT tools, ethical use of social media and appropriate professional etiquette, as individuals and team members.*	
	Contents: 1.1 Introduction to Theory of Communication a) Definition b) Objectives c)The Process of Communication 1.2 Methods of Communication i. Verbal (Written & Oral) ii. Non-verbal a. Non-verbal cues perceived through the five senses: (Visual, Auditory, Tactile, Olfactory and Gustatory cues) b. Non-verbal cues transmitted using: (Body, Voice, Space, Time and Silence) 1.3 Barriers to Communication a) Mechanical/External b) Physical/Internal c) Semantic & Linguistic d) Psychological e) Socio-Cultural 1.4 Communication at the Workplace a) Corporate Communication - Case Studies b) Short Group Presentations on Business Plans c) Selecting Effective Communication Channels 1.5 Professional Etiquette a) Formal Dress Code b) Cubicle Étiquette c) Formal Dining Étiquette d) Responsibility in Using Social Media e) Showing Empathy and Respect f) Learning Accountability and Accepting Criticism g) Demonstrating Flexibility and Cooperation	**7**
	Self-Learning Topics: *Visit nearby Government offices e.g. Passport/Post/Electricity/Telephone, as such, communicate with employees and get related information. Evaluate your communication with them & find out the flaws and/or barriers in the communication*	

	process that you faced. Document it for further discussion. *Reading up on various case studies depicting barriers in communication which led to conflicts; finding alternative methods of resolving them*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Demonstrate competence in verbal and non-verbal communication and apply suitable cues to communicate effectively as an individual or in a group . (7.2.2, 8.2.1, 8.2.3, 9.2.3)* *LO1.2: Exhibit ethical use of social media, flexibility and empathy in the professional space. (7.2.2, 8.2.2 ,8.2.3, 11.1.1)* *LO1.3: State the need for and implement appropriate grooming and ethical way of presenting oneself. (11.1.1)* *Activity:* *1.Group Discussion , Debates on various socially relevant topics - Minimum three rounds to be conducted for facilitating enough practice.*	
02.	***Verbal Aptitude For Employment*** ***Learning Objective:*** *To facilitate clear comprehension, interpretation, and evaluation of verbal technical and non-technical data.* *To facilitate fluent and precise presentation skills, in social, academic, and professional situations, with correct syntax, lexicon and semantics.*	**3**
	Contents: 2.1 Vocabulary Building a) Meaning of Words in Context b) Synonyms & Antonyms c) Avoiding redundancy d) Word Form Charts e) Prefixes & Suffixes 2.2 Grammar a) Identifying Common Errors b) Subject - Verb Agreement c) Articles d) Preposition e) Pronunciation	
	Self-Learning Topics: *Maintain a journal of new vocabulary; add, learn and apply in conversation 3 new words daily.*	
	Learning Outcomes:	

	A learner will be able to *LO2.1: Identify the commonly found grammatical errors in the written and spoken format of communication. (9.1.1, 9.1.2)* *LO2.2: Apply appropriate words and parts of speech such as prefixes, suffixes, synonyms , antonyms , idioms , proverbs and cliches in the written and oral form of communication. (9.1.1,9.2.2)* *LO2.3: Listen to grammatically correct input , understand and analyse the same .(11.3.1)* *Activity : Solving Two verbal Aptitude Tests as assignment work .* *Solving grammar practice tests based on the module .*	
03.	***Developing Basic Language Skills-LSRW Skills*** ***Learning Objective:*** *To listen, read, write, summarise and present concrete technical and non-technical data precisely with minimum errors keeping the audience in mind.* *To generate and deliver a speech and/or presentation using both rational and out of the box thinking.*	**5**
	Contents: 3.1 Listening Skill- Listening to recordings of Formal and Informal communication situations. 3.2 Speaking Skill- Developing and Delivering Short Speeches, Informative Speeches (that center on people, events, processes, places, or things), Persuasive Speeches (to persuade, motivate or take action) and Special Occasion Speeches- (anchoring, hosting, compering events in institute) a) Pair-work Conversational Activities / Role play b) Introducing Self and/or a Classmate 3.3 Reading Skill Reading Short and long passages for comprehension. 3.4 Writing Skill- Summarization of non-technical passages, reports. Writing review of Short Stories - *Lamb to the Slaughter- by Roald Dahl, The Green Leaves* by Grace Ogot, *Uncle Podger Hangs a Picture* by Jerome K Jerome, R.K. Narayan (*Malgudi Days*), Ruskin Bond (*Celestial Omnibus*). Writing review of Movies- Toilet :Ek Prem katha, Padman, Dangal, Taare Zameen Par, Masan, Gulabi.	

	a) Graphic Organizers for Summaries i. Radial Diagrams like Mind Maps ○ Flow Charts ○ Tree Diagrams Cyclic Diagrams ii. Linear Diagrams like Timelines ○ Pyramids ○ Venn Diagrams b) Point-form Summaries c) One-sentence Summaries of Central Idea	
	Self-Learning Topics: *Read either autobiography or biography of A.P.J. Kalam, Nelson Mandela, or any such revolutionary thinker and write its summary.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Listen to team members, peers respectfully, without prejudice to understand ideas and opinions in various formal, informal situations. (8.2.2, 8.2.3, 9.2.1, 9.2.3)* *LO3.2: Create and deliver effective formal/ informal speeches in a professional set up. (8.2.4, 9.2.2, 9.3.2, 11.1.1)* *LO3.3 Read and comprehend long/short, technical/non-technical passages along with summarising it in paragraph format / graphical organisers. (9.1.1, 9.1.3, 9.2.1)* *Activity:* *1.Listening skill - Listening to audio and video content of various types like Monologues, dialogues, formal talk and discussion about the same.* *2. Self-Introduction and introducing others - Learning formal self-introduction and introducing colleagues through practice activity.* *3.Reading of short stories/ watching movies - writing summaries and learning to critically evaluate them – Students will be given a selected list of short stories/ movies with social messages and guided for writing summaries after critical evaluation of the same.*	
04.	***Business Correspondence*** ***Learning Objectives:*** *To train in writing strategies for comprehensive academic and business correspondence.* *To promote competent writing skills in business, technology and academic areas using effective media.* *To find and fill gaps in knowledge required for basic written business correspondence and continued professional growth.*	**7**
	Contents: 4.1. Seven Cs of Business Correspondence 1) Completeness 2) Conciseness 3) Consideration 4) Concreteness	

	5) Clarity 6) Courtesy 7) Correctness 4.2. Parts of a Formal Letter and Format 1) Parts/Elements of a Formal Letter i. Letterhead and/or Sender's Address ii. Dateline iii. Reference Number iv. Inside Address v. Attention Line (Optional) vi. Salutation vii. Subject Line / Caption Line / Reference Line viii. Body of the Letter ix. Complimentary Close x. Signature Block xi. Identification Marks xii. Enclosures/Attachments xiii. Carbon Copy Notation (courtesy copy) xiv. Postscript 2)Complete/ Full Block Format 4.3 Emails 1) Format of Email 2) Features of Effective Emails 3) Language and style of Emails 4.4 Types of Letters in Both Formal Letter Format and Emails - 1. Enquiry letter (internship, placement, workshop) 2. Request/Permission Letters (Leave letter, apology letter, seeking permission for facilities)	
	Self-Learning Topics: *Collect Official letters and evaluate them for language, tone, format and content*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the 7 C's of correspondence to basic official correspondence. (7.1.1, 7.2.2)* *LO 4.2: Draft an Enquiry /Request/Permission letter in both letter and Email format, for various professional situations. (9.3.2, 11.1.1)* *Activity:* *1.Assignment on Business Correspondence- practice for drafting various business letters*	
05.	***Basic Technical Writing*** *Learning Objective/s*: *To promote effective technical writing skills in business, technology and academic arenas.* *To create easy to understand technical documents with logical flow of ideas keeping the end user in mind.*	**6**

To identify gaps in research papers and attempt to source information for the same.

To comprehend the need for ethical concepts such as Plagiarism checks and Copyright in professional writing.

Contents:

5.1. Introduction

1) What is Technical Writing?
2) Importance and Principles of Technical Writing
3) Difference between Technical Writing & Literary Writing

5.2. Writing User Instructions

1) User Instructions
2) Hazard Notations /Special Instructions- (Note, Precaution Warning, Caution and Danger)

5.3 Basics of Research

1) Importance of Research
2) Types of research
3) How to select a topic
4) Structure of a Technical Research Paper
5) Referencing styles (APA, IEEE)

5.4 Intellectual Property Rights -

1) Understanding the importance of Copyrights
2) Paraphrasing, referencing and In-text citations
3) Running a Plagiarism Check on Paraphrased Passages
4) Ethical behaviour: case studies

Self-Learning Topics: *Collect User Manuals and study them for language and tone of instructions, hazard notations, and order of instructions.*

Learning Outcomes :

A learner will be able to

LO5.1: Write and present a clear set of instructions for the end user for a particular task. (9.1.3, 9.2.2)

LO5.2 :Critically choose a research topic and write the problem statement and Hypothesis (11.3.1)

LO5.3: Identify the utility and importance of Copyrights . (7.2.2, 9.3.1, 11.1.1)

LO5.4: Generate plagiarism reports by running a plagiarism check on the select document. (7.2.2, 9.3.2, 11.3.1)

Activity:

1.Assignment on writing accurate technical instructions for the end user.

2. Selection of Ethical Case Study, Analysis, discussion and report documentation followed by a presentation .

	Activities for Practical: *1. Listening skill - Listening to audio and video content of various types like Monologues, dialogues, formal talk and discussion about the same.* *2. Self-Introduction and introducing others - Learning formal self-introduction and introducing colleagues through practice activity.* *3. Group Discussion on various socially relevant topics - Minimum three rounds to be conducted for facilitating enough practice.* *4. Debates on several socially relevant issues- Two rounds to be conducted.* *5. Selection of Ethical Case Study, Analysis, discussion and report documentation followed by a presentation .* *6. Reading of short stories/ watching movies - writing summaries and learning to critically evaluate them – Students will be given a selected list of short stories/ movies with social messages and guided for writing summaries after critical evaluation of the same.* *7.Selecting a socio-psychological or socio-technical or socio economic problem, creating a short paper in the relevant format. Detailed discussion about format for a technical paper will be held. Students will create a short research paper using the given template followed by a presentation.* *8. Assignment on Barriers to communication - Students will document their observations about the barriers faced during the self learning activity and present the possible solutions for the same.* *9. Assignment on Business Correspondence- practice for drafting various business letters. Students will refer to the various sample business letters collected as self learning activity.* *10. Assignment on writing accurate technical instructions for the end user. Students will refer to the various sample user manuals collected as self learning activity.* *11.Assignment on Verbal Aptitude Test - Two verbal Aptitude Tests will be conducted .*	**2** **2** **6** **4** **3** **3** **2** **2** **2** **2** **2**
	Course Conclusion	**01**
	Total	**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.2.2	Treat other team members respectfully

8.2.3	Listen to other members
8.2.4	Maintain composure in difficult situations
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.2.3	Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team.
9.3.1	Create technical figures, reports with data to complement reports and presentations
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	Describe the rationale for the requirement for continuing professional development
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Evaluate information they listen to and present effectively , convincingly and ethically before an audience . (*LOs 1.2, 1.3, 2.1, 3.1,3.2, 5.1)*
2. Read and analyse objectively, summarize graphically and paraphrase effectively. (*LOs 2.1, 2.2, 3.3,)*
3. Communicate effectively and ethically along the various channels of communication within a business organization and follow the general code of conduct and professional etiquette of the organization. (*LOs 1.1, 1.3, 3.2, 4.1, 4.2)*
4. Write a set of effective and easy to understand academic articles and technical instructions and convey the same using global information technology and Netiquette. *(LOs 1.3, 2.2, 4.1, 4.2, 5.1, 5.3)*
5. Conduct ably and ethically within the social circles with empathy and confidence, thus exhibiting a well-groomed and balanced personality. (*LOs 1.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
AEC201.1							3	3	3		3
AEC201.2									3		3
AEC201.3									3		3
AEC201.4							3		3		3
AEC201.5									3		3
Average							3	3	3		3

Text Books :

1. Sanjay Kumar, Pushp Lata(2018).CommunicationSkills,NewDelhi:OxfordUniversityPress
2. Rizvi, A. M. (2010). Effective Technical Communication: A guide for Scientists and Engineers.
3. Dahl, R. (1953), "Lamb to the Slaughter". *Harper's Magazine*. Harpers.
4. *"*The Green Leaves*", Land without Thunder, Short Story* by Grace Ogot, East African Publishing House, Kenya, 1068
5. Sanjay Kumar & Pushp Lata (2018). Communication Skills, New Delhi: Oxford University Press

Reference Books:

1. Soft Skills, Dr. k. Alex, S. Chand Publication, 2009
2. English Grammar and Composition, S.C. Gupta, Arihant Publication, 2014
3. Oxford handbook of Commercial Correspondence, A. Ashley, Raman, M., & Sharma, S. (2016). Technical Communication: Principles and practice. New Delhi: Oxford University Press
4. Lewis, N. (2014). Word power made easy. Random House USA.

CONTINUOUS INTERNAL EVALUATION (50 Marks)

1. Listening, Speaking

GD/Debating Skills + group dynamics (10)

2. Ethical Case Study project (10)
   (Continuous work as individual with set due date)

3. Critical Analysis of a Short Story/ Movie and presentation (10)
   (Continuous work as a team with set due date)

4. Short Technical Paper on any Socio-Technical problem and PPT presentation.(10)
   (Continuous work as individual with set due date)

5. Assignments (05)

6. Regularity and active participation (05)

Course Type	Course Code	Course Name	Credits
ESC	ESC203	BASIC ELECTRONICS ENGINEERING	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
15	20	40	1	1.5	75

Pre-requisite:

1. ESC102- Basics of Electrical Engineering
2. BSC102- Engineering Physics-I

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO11: Life-long learning

Course Objectives:

1. To impart the knowledge to demonstrate competence in comprehending the concepts of semiconductor diodes and solve the problems to analyse its applications.
2. To demonstrate the ability to execute a solution process and analyse results to design real life applications such as an amplifier, switch, etc.
3. To introduce number system and use logic gates to analyse and design circuits for a given expression.
4. To recognize the utilisation of measuring devices and its working.
5. To introduce various transducers and sensors to adapt to the current technologies regarding new developments in the relevant fields.

Module	Details	Hrs.
	Course Introduction Electronics is a branch of engineering that has grown exponentially in recent years, and now electronics has become a very important part of our lives. This is foundation course deals with fundamental concepts of semiconductors devices, transistors, number system, logic gates, measuring instruments, transducers and sensors. With the growing popularity and production of electric vehicles (EVs) in India, it is projected that semiconductor use in fields including safety, electrification, communication, and networking would rise.	**01**
01.	**Introduction to Basic Electronic system** ***Learning Objective:***	**5-7**

	1. *To demonstrate competence in engineering fundamentals and specialized engineering knowledge to comprehend the concepts of semiconductor diodes.* 2. *To identify the engineering systems, variables, and parameters to solve the problems for analyzing the applications of semiconductor diodes.*	
	Contents: Semiconductor Diode - Ideal versus Practical, Characteristics and Parameters, Diode Approximations, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Diode as clipper and clampers; Zener diode- Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications.	
	***Self-Learning Topics**: LASER diode*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to comprehend the characteristics and parameters of semiconductor diodes. (P.I.-1.3.1)* *LO 1.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend diode equivalent circuit and its load line analysis. (P.I.-1.4.1)* *LO 1.3: Identify engineering systems to analyze the applications of diode such as switch, rectifier, clipper, clampers etc. (P.I.-2.1.2)* *LO 1.4: Identify existing methods for analyzing voltage, currents of zener diode and opto –electronic devices. (P.I.-2.2.3)*	
02.	**Introduction to Transistor** ***Learning Objective:*** ***1.*** *To demonstrate competence in engineering fundamentals and specialized engineering knowledge to comprehend the concepts of bipolar junction transistor.* ***2.*** *To identify the engineering systems, variables, and parameters for analyzing the applications of bipolar junction transistor as an amplifier and also as a switch.*	**6-8**
	Contents: Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Potential Divider Bias circuit; DC load line analysis, Q point, comparison of characteristics of transistors in different configurations, Applications: Transistor as an amplifier, transistor as a switch.	
	***Self-Learning Topics:** Self-biasing.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental engineering concepts to comprehend the concept of biasing with potential divider bias circuit. (P.I.-1.3.1)* *LO 2.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend the types and characteristics of bipolar junction transistor. (P.I.-1.4.1)*	

	LO 2.3: Identify engineering systems to find gain, operating point of bipolar junction transistor etc. (P.I.-2.1.2) *LO 2.4: Identify solution methods to use bipolar junction transistor as an amplifier and switch. (P.I.-2.2.3)*	
03.	**Introduction to Number system and Logic gates** ***Learning Objective:*** 1. *To analyze the number systems, different types of numbers and Boolean algebra.* 2. *To Demonstrate the ability to generate alternative design solutions using logic gates.*	**5-7**
	Contents: Number System: Binary Numbers systems, Decimal to Binary and Binary to Decimal Conversion, BCD, Octal and Hexadecimal numbers, Negative numbers representation, 1's, 2's, Complements, BCD codes, Gray code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Logic gates: Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs).	
	Self-Learning Topics: *Flip- flops*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Integrate mathematical tools to perform conversion in number System. (P.I.- 2.2.2)* *LO 3.2: Compare alternative solutions to select the best methodology to implement logic gates. (P.I.-2.2.4)* *LO3.3: Determine design objectives to implement electronic circuits using logicgates (P.I.-3.1.6)* *LO3.4: Apply formal design principles to build simplified circuits using universal gates. (P.I.-3.3.3)*	
04.	**Electronic Instruments** ***Learning Objectives:*** *To identify and describe the components of a generalized measurement system and explain key performance characteristics of measurement instruments*	**1-3**
	Contents: Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	Self-Learning Topics: ----	
	Learning Outcomes: *A learner will be able to*	

	LO 4.1: Apply fundamental engineering concepts to comprehend generalized measurement system (P.I.-1.3.1) *LO 4.2: Apply concepts of electronics and communication engineering and allied disciplines to explain key performance characteristics of measurement instruments. (P.I.-1.4.1)* *LO 4.3: Comprehend technical datasheets of instruments. (P.I.-11.3.1)*	
05.	**Introduction to Transducers** ***Learning Objective/s:*** *To demonstrate competence in engineering fundamentals to introduce the concept transducer for the desired application.* **Contents:** Transducers, classification of transducers, selection of transducers, Resistance- temperature detector (RTD), inductive transducers, Linear variable differential transformer (LVDT). ***Self-Learning Topics: --*** ***Learning Outcomes :*** *A learner will be able to* *LO 5.1: Apply fundamental engineering concepts to comprehend the concept of transducers and its working. (P.I.-1.3.1)* *LO 5.2: Apply concepts of electronics and communication engineering to comprehend various types of transducers used in electronics. (P.I.-1.4.1)*	**2-4**
06.	**Introduction to Sensors** ***Learning Objective/s:*** *To demonstrate competence in engineering fundamentals to comprehend the concepts of sensor as per the application.* **Contents:** Definition, Classification & selection of sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive. ***Self-Learning Topics:*** *Sensors used in IOT.* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply laws of natural science to an engineering problem to understand the concept of sensors. (P.I.-1.2.1)* *LO 6.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend the types of sensors. (P.I.-1.4.1)*	**3-5**
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
1.2.1	Apply laws of natural science to an engineering problem
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.2.2	Identify/ assemble/integrate mathematical tools to information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
3.1.6	Determine design objectives, functional requirements and arrive at specifications.
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
11.3.1	Source and comprehend technical literature and other credible sources of information.

Course Outcomes: A learner will be able to -

1. Apply the fundamentals of engineering to demonstrate the concepts of semiconductor diodes and analyse its applications. *(LO 1.1, LO 1.2, LO1.3, LO1.4*)
2. Apply the fundamentals of engineering to design transistor-based applications such as an amplifier, switch, etc. *(LO 2.1, LO 2.2, LO2.3, LO2.4*)
3. Formulate mathematical models to introduce number system and use logic gates to design circuits for a given expression. *(LO 3.1, LO 3.2, LO3.3, LO3.4*)
4. Recognize the utilisation of measuring devices and its working. *(LO 4.1, LO 4.2, LO 4.3*)
5. Apply the fundamentals of engineering to introduce various transducers and sensors to adapt to the current technologies regarding new developments in the relevant fields. *(LO 5.1, LO 5.2, LO6.1, LO6.2*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESC203.1	3	3									
ESC203.2	3	3									
ESC203.3		3	3								
ESC203.4	3										2
ESC203.5	3										
Average	3	3	3								2

Text Books :

1. Electronic Devices and Circuit Theory (11th Edition), Robert Boylestad, Pearson Education Limited 2014.
2. Electronics A Systems Approach, Neil Storey, 2011, 4th edition, Pearson Education Publishing Company Pvt. Ltd.
3. Electronic Devices and Circuits, Salivahanan, N Suresh Kumar, 2013, 3rd edition, McGraw Hill Publications.
4. Modern Digital Electronics (4th Edition), R. P. Jain, Tata McGraw Hill Education Private Limited.
5. Sensors and Transducers (3rd Edition), Ian Sinclair, BSP Professional Books, 2001.

Reference Books :

1. Electronic Devices and Circuits, David A Bell, 2016, 5th Edition, Oxford.
2. The Art of Electronics 3rd Edition by Horowitz and Hill, 3rd edition, 2015.
3. Digital Logic and Computer Design, M. Morris Mano, 2008 ISBN-978-81-203-0417-8, PHI Learning.
4. Electronic Instrumentation and Measurements (3rd Edition) – David A. Bell, 2013, Oxford University Press.
5. Electronic Communication Systems, George Kennedy, 4th Edition, TMH, 2009.

Other Resources :

1. NPTEL Course: Introduction to Basic Electronics By Prof. T.S. Natarajan, Basic Electronics andLab, IIT Madras :-Web link- https://nptel.ac.in/courses/122106025
2. NPTEL Course: Digital Electronic Circuits By Prof. Goutam Saha, NOC:Digital ElectronicCircuits, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/108105132
3. NPTEL Course: Introduction to Microcontrollers & Microprocessors By Prof. Dr. S.P. DasMicrocontrollers and Applications, IIT Kanpur, Web link- https://nptel.ac.in/courses/107/106/10710608

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(15 Marks)

1. *Numerical Assignment/s (min 20 problems) – 04 Marks*
2. *Class test based on above numerical assignment – 04 Marks*
3. *Open book test/ Open notes test: 04 Marks*
4. *Regularity and active participation:03 Marks*

2. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (40 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 30% weightage, and the syllabus covered from MSE to ESE carrying 70% weightage.

Course Type	Course Code	Course Name	Credits
BSC-LC	BSL203	ENGINEERING PHYSICS-II LABORATORY	0.5

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
25	-	-	-	-	25

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and Collaborative Team Work
4. PO9: Communication

Course Objectives:

1. To demonstrate the fundamental concepts of physics and evaluate the process of an experiment/project quantitatively and qualitatively.
2. To improve the knowledge gained in the theory course.
3. To develop the abilities of modelling, measurements, observations and analysing data.
4. To develop the experimental skill in assembling and handling laboratory instruments.

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Experiment 1** ***Learning Objective:*** *To use the concept of miller indices to identify principal crystal planes in simple cubic structure.*	**02**
	Determination of interplanar distance for principal planes in simple cubic structure.	
	Learning Outcome: *LO1.1*: *A learner will be able to apply the concept of miller indices and analyze principal crystal planes to determine the interplanar distance in simple cubic structure. (P.I.- 1.2.1, 1.3.1, 4.3.1, 4.3.3)*	

02.	**Experiment 2** ***Learning Objective:*** *To simulate XRD pattern for a given crystal system* Simulation of X-ray Diffraction (XRD) pattern of Sodium Chloride structure to find lattice parameters. ***Learning Outcome:*** *LO2.1. A learner will be able to apply the knowledge of x-ray diffraction and analyze the crystal structure of sodium chloride by simulating XRD pattern using software and write the result. (P.I.- 1.2.1, 1.3.1, 4.1.3, 4.3.3)*	**02**
03.	**Experiment 3** ***Learning Objective:*** *To study the hysteresis loop of a ferromagnetic material.* Determination of area of hysteresis curve (B-H curve) of a ferromagnetic material. ***Learning Outcome:*** *LO 3.1: A learner will be able to apply basic concepts of magnetization and analyze the B-H curve of a ferromagnetic material and write the result. (P.I.- 1.2.1, 1.3.1, 4.3.1, 4.3.3).*	**02**
04.	**Experiment 4** ***Learning Objectives:*** *To determine the parameters which characterize a dielectric material.* Determination of dielectric constant of Bakelite material. ***Learning Outcome:*** *LO4.1: A learner will be able to apply the knowledge of dielectrics and analyse experimental data to determine the dielectric constant of the given material and write the result. (P.I.- 1.2.1, 1.3.1, 4.3.1, 4.3.3)*	**02**
05.	**Experiment 5** ***Learning Objective/s:*** *To simulate and visualize structures of various nanomaterials.* Simulation of structures of carbon nanomaterials to find C-C bond length. ***Learning Outcome :*** LO5.1: *A learner will be able to apply the knowledge of nanomaterials and analyse the structure using simulation software and write the result. (P.I.- 1.2.1, 1.3.1, 4.1.3, 4.3.3)*	**02**
06.	**Course Project**	**03**

	Learning Objective/s: *To explore the application of concept of physics in different fields by demonstrating a chosen project.*	
	Report writing and Demonstration of the project.	
	Self-Learning Topics: -	
	Learning Outcomes: *A learner will be able to* *LO6.1: apply the concepts of physics to execute, demonstrate and present the project effectively as a team. (P.I.- 1.2.1, 1.3.1, 4.2.1, 4.3.1, 8.1.2, 8.3.1,9.1.2, 9.2.2)*	
	Course Conclusion	**01**
	Total	**15**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of physics to an engineering problem.
1.2.2	Apply the formulae derived from the concept to solve engineering problem.
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities.
4.2.1	Design and develop experimental approach, specify appropriate equipment and procedures.
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data.
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective teamwork, to accomplish a goal.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.2	Produce clear, well-constructed, and well- supported written engineering documents.
9.2.2	Deliver effective oral presentations to technical and non- technical audiences.

Course Outcomes:

1. Learners will be able to apply the fundamental knowledge of different materials to determine various parameters through relevant experiments.
(*LO 1.1, LO3.1, LO 4.1*)

2. Learners will be able to apply the basic concept of different materials to simulate their structures and diffraction pattern using relevant software. (*LO 2.1, LO5.1*)

3. Learners will be able to apply fundamental knowledge of physics for the execution, presentation of the chosen project as a team and write effective report. (*LO 6.1*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSCLC203.1	3			3							
BSCLC203.2	3			3							
BSCLC203.3	3			3							
BSCLC203.4	3			3				3	3		
Average	3			3				3	3		

Text Books :

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

Reference Books :

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
3. Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1st Edition, Wiley-Interscience.

Other Resources :

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.edu

IN-SEMESTER ASSESSMENT (25 MARKS)

Lab Performance: 10 marks

1. Project (Final Report and Demonstration): 10 marks
2. Regularity and active participation: 5 marks

Course Type	Course Code	Course Name	Credits
BSL	BSL204	ENGINEERING CHEMISTRY II LABORATORY	0.5

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
25	-	25	25	-	25

Pre-requisite: Nil

Program Outcomes addressed:

1. PO1: Engineering Knowledge:
2. PO2: Problem Analysis
3. PO4:Conduct investigation of complex problems
4. PO6: The engineer and the world
5. PO8: Individual and collaborative teamwork
6. PO9:Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
7. PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

Course Objectives:	
1.	To enable the students to apply the laws of chemistry to an engineering problem.
2.	To acquaint the students with practical knowledge of the basic concepts of chemistry to gainexperimental skill.
3.	To enable the students to utilize the fundamental laboratory techniques for analysis.

Module	Details	Hrs.
	Course Introduction 1. Code of conduct in chemistry laboratory 2. Safety and precautions to be observed in chemistry laboratory 3. Orientation on evaluation of laboratory performance	**01**

01.	**Experiment 1** ***Learning Objective/s:*** ***To calculate percentage of iron in plain carbon steel and relate it with the classification of plain carbon steel.*** To determine the percentage of iron present in a plain carbon steel *Self-Learning Topics: Nil* ***Learning Outcomes:*** *LO -1.1 A learner will be able to calculate the percentage of iron in plain carbon steel by redox titration method.(1.2.1) (1.3.1), (2.2.3), (4.2.1), (4.3.1), (4.3.3)*	**02**
02.	**Experiment 2** *Learning Objective/s:* *To apply the knowledge of condensation polymerization for the synthesis of urea formaldehyde.* **Synthesis of Urea formaldehyde.** ***Self-Learning Topics: Nil*** ***Learning Outcomes:*** *LO-2.1 A learner will be able to synthesize thermosetting resin using condensation polymerization reaction and calculate its yield and state its societal benefits.(1.2.1) (1.3.1), (2.2.3), (4.2.1),(4.3.1),(4.3.3),(6.1.1).*	**02**
03.	**Experiment 3** *Learning Objective/s:* *To compare the viscosity of pure solvent and the solution of polymer for calculating the molecular weight of polymer.* To Determine molecular weight of a polymer using Ostwald's viscometer. ***Self-Learning Topics: Nil*** ***Learning Outcomes:*** *LO-3.1 A learner will be able to c*alculate the specific viscosity of polymer with respect to pure solvent and its molecular weight using Ostwald's Viscometer (1.2.1), (1.3.1), (2.2.3), (4.1.3), (4.2.1), (4.3.1), (4.3.3)	**02**
04.	**Experiment 4** *Learning Objective/s:* *To construct the Daniel cell and calculate its E^0 using Nernst equation.* To determine the emf of galvanic cell-Daniel cell. ***Self-Learning Topics: Nil*** ***Learning Outcomes:*** *LO-4.1 A learner will be able to construct and calculate E^0 of Daniel cell using electrode reactions and compare with theoretical values to conclude whether Daniel cell is working or not. (1.2.1), (1.3.1), (2.2.3), (4.1.3), (4.2.1),*	**02**

	(4.3.1),(4.3.3)	
05.	**Experiment 5** *Learning Objective/s:* *To determine the concentration of iron and verify Beer Lambert's law.*	**02**
	To determine iron from the given sample using UV-Visible spectrophotometer.	
	Self-Learning Topics: Nil	
	Learning Outcomes :	
	LO-5.1 A learner will be able to measure the absorbance of standard and unknown concentrations of given analyte using UV-Visible spectrophotometer and verify Beer Lambert's law (1.2.1), (1.3.1), (2.2.3), (4.1.3),(4.2.1),(4.3.1),(4.3.3).	
06.	***Demonstration*** *Learning Objective:* *To develop the basic knowledge of analytical chemistry using titrimetric experiment.*	**04**
	Demonstration of titrimetric experiment and conclusion.	
	Self-Learning Topics: Nil	
	Learning Outcomes: *LO-6.1 A learner will be able to analyze and calculate the proposed substances in an experiment using fundamental laws and basic concepts of engineering chemistry and demonstrate the results as a team (1.2.1), (1.3.1),(2.1.3,(2.2.3),(4.2.1),(4.3.1),(4.3.3), (8.1.1), (8.3.1),(9.1.2), (9.1.3), (11.3.2), (11.3.3)*	
	Total	**15**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering Problem.
1.2.2	Apply the formulae based on the concepts of engineering chemistry for solving the numericalproblems.
1.3.1	Apply fundamental engineering chemistry concepts to solve engineering problems.
2.1.3	Identify the engineering chemistry concepts to analyse the given problem
2.2.3	Identify the existing processes/ solution methods for solving the problems
4.1.3	Apply appropriate instrumentation to make measurement of physical and chemical quantity. (modified)
4.2.1	Design and develop an experiment approach, specify appropriate equipment and procedures.
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data.
4.3.3	Represent data in tabular/ graphical forms so as to facilitate analysis and explanation of the data and drawing of conclusions.

6.1.1	Identify and describe the various roles of materials particularly as pertains to protection of thepublic and public interest at global, regional and local level
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
8.3.1	Present result as a team with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and non-technical information
9.1.2	Produce clear, well-constructed, and well-supported written project report.
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.2	Deliver effective oral presentations to technical and non-technical audiences.
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.
11.3.3	Demonstrate an ability to identify and analyse new chemical processes and analytical skills in open ended experiments.(New)

Course Outcomes: A learner will be able to -

1. Apply the laws of electrochemistry and spectroscopy for performing the practicals. (*LO- 4.1, LO-5.1)*
2. Analyze the materials for engineering applications. (*LO-1.1, LO-3.1, LO-5.1)*
3. Synthesize the polymer and use it for societal benefits. (*LO-2.1)*
4. Demonstrate an ability to work effectively in a team for the project. (*LO-4.1)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BSL204.1	3			3							
BSL204.2	3			3							
BSL204.3	3			3							
BSL204.4	3	3		3				3	3		3
Average	3	3						3	3		3

Text Books :

1. Practical book in Engineering Chemistry by Dr. Pijus Khatua and Debashree Singh, First edition, 2016, Platinum Publishers
2. Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

Reference Books :

1. Experiments in Engineering Chemistry by Payal Joshi, first edition, 2016, I.K. International Publishing House Pvt. Ltd.

Other Resources :

1. Online chemistry library for open access text books: https://chem.libretexts.org
2. https://vlab.amrita.edu/?sub=2&brch=190&sim=1546&cnt=1

IN-SEMESTER ASSESSMENT (25 MARKS)

1. Lab Performance: 10 Marks
2. Demonstration of the experiment: 10 marks
3. Regularity and active participation: 5 marks

Course Type	Course Code	Course Name	Credits
ESL	ESL204	ENGINEERING GRAPHICS LABORATORY	02

Examination Scheme		
Continuous Assessment	End Semester Exam (ESE)	Total Marks
50	50	100

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO5: Modern tool usage
4. PO9: Communication

Course Objectives:

1. To inculcate proper understanding of the theory of projection.
2. To enable students to understand and represent three-dimensional objects on a two-dimensional surface in a way that accurately conveys their shape, size, and orientation.
3. To acquaint students with representing internal features of a three-dimensional object by way of section that accurately conveys their internal orientation.
4. To communicate proper ideas by representing the two-dimensional views into a three dimensional object.
5. To enable students to read and interpret a given orthographic projection to draw the missing view.

Module	Details	Hrs.
	Course Introduction This is foundation course which deals with fundamental concepts oftechnical drawing and modern tools associated with it. This course will empower the imagination and visualization which will help in communicating the technicality of the product.	**01**
01.	**Introduction to Engineering Graphics** ***Learning Objective:*** *To identify different types of lines and dimensioning standards as per IS system.*	**06-08**
	Contents: Principles of Engineering Graphics and their significance, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to CAD tool (AutoCAD): An overview of AutoCADsoftware to make simple drawings.	
	Lab Activity: To demonstrate the basic commands in AutoCAD software.	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply mathematical and engineering principles and CAD tools to produce precise 2D engineering drawings by selecting appropriate scales, line types, dimensioning practices, and IS-standard conventions; utilizing AutoCAD commands to generate professional-quality figures. (P.I.-1.1.1, P.I.-1.3.1, P.I.-5.1.1, P.I.-5.2.2, P.I.-9.1.2, P.I.-9.3.1)*	

02.	**Orthographic and Sectional Orthographic Projections** ***Learning Objective:*** *To develop the imagination in creating the orthogonal and sectional orthographic views for communicating the features in the product.* **Contents:** **Projection of Points and Lines:** Projection of points in differentquadrants. Projection of lines keeping the ends in different quadrants. **Orthographic Projections:** Concept of First Angle and Third Angle Projection. Fundamentals of Orthographic Projections. Different views ofa simple machine part as per the first angle projection method recommended by I.S. Multi view drawing from pictorial views using CADSoftware (AutoCAD) **Sectional Orthographic Projections:** Full or Half Sectional views of the Simple Machine parts. Sectional view using CAD Software (AutoCAD). **Lab Activity 1:** To demonstrate the ability to project points and lines located in all four quadrants onto the principal planes by constructing accurate front and top views of each point and line segment ensuring correct reference lines and quadrantal positions. ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply fundamental and mechanical engineering concepts to produce accurate orthographic and sectional projections, classifying true and apparent line lengths in quadrants, constructing first angle front, top, and side views, interpreting full and half sections, and applying justified corrections to projection errors. (P.I.-1.3.1, P.I.-1.4.1, P.I.-2.1.3, P.I.-2.2.3)* **Lab Activity 2:** To demonstrate the ability to convert the isometric drawings into orthogonal and sectional orthographic drawings. ***Learning Outcomes:*** *A learner will be able to* *LO 2.2: Apply essential AutoCAD commands to reproduce orthographic and sectional drawings by applying layers, snaps, object tracking, dimensioning, section lines, hatch patterns, and legends to create clear, IS-compliant visuals that support technical reports and presentations. (P.I.-5.1.1, P.I.-5.2.2, P.I.-9.1.2, P.I.-9.3.1)*	**18-20**
03.	**Isometric Views** ***Learning Objective:*** *To develop the ability in visualization of the two-dimensional views of the object to produce the isometric drawing.* **Contents:** Isometric Drawing: Principles of Isometric Projection, Isometric Views, Conversion of Orthographic Views to Isometric Views. (Excluding Sphere). Construction of Isometric View from Orthographic views with CAD Software (Auto CAD) **Lab Activity:** To demonstrate the principles of isometric projection by manually constructing an accurate isometric drawing from given orthographic views ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply fundamental engineering principles to interpret two-dimensional orthographic projections and manually construct precise isometric drawings that accurately convert orthographic views into three-dimensional representations (P.I.-1.3.1, P.I.-2.2.1, P.I.-9.1.2, P.I.-9.3.1).*	**10-12**

	Lab Activity: To demonstrate the ability to convert the orthographic views into isometric drawings using Auto CAD.	
	Learning Outcomes: *A learner will be able to* *LO 3.2: Apply mechanical engineering principles to interpret and construct accurate isometric projections by identifying geometric features of components, selecting and justifying manual construction methods, and using AutoCAD commands to generate precise isometric views. (P.I.-1.4.1, P.I.-2.1.3, P.I.-2.2.3, P.I.-5.1.1, P.I.-5.2.2)*	
04.	**Reading of Orthographic Views** ***Learning Objectives:*** *To develop the ability of the students to read the orthographic and sectional orthographic projections to draw the missing views.*	**05-06**
	Contents: **Orthographic Reading:** The identification of missing views from the givenviews. Creation of the third view from the two available views so that all the details of the object are obtained using CAD Software (AutoCAD).	
	Lab Activity: To interpret orthographic and sectional projections, identify any missing views, and manually construct the third view from two given projections to fully represent all features of the object.	
	A learner will be able to *LO 4.1: Apply fundamental engineering concepts to analyze and reconstruct complete orthographic and sectional projections by breaking down two-view drawings to locate missing views, drafting sectional views that expose internal details, and generating sectional projections using projection theory. (P.I.-1.3.1, P.I.-2.2.1, P.I.-9.1.1, P.I.-9.1.2)*	
	Lab Activity: To demonstrate the ability to visualize and interpret the missing views of Orthographic projections.	
	Learning Outcomes: *A learner will be able to* *LO 4.2: Apply mechanical engineering principles and leverage AutoCAD drafting commands to interpret two-view projections, generate missing elevations, and produce accurate orthographic and sectional drawings that fully reveal internal features. (P.I.-1.4.1, P.I.-2.2.3, P.I.-9.1.2, P.I.-9.3.1)*	
05.	**Projection of Planes and Solids** ***Learning Objective:*** *To develop the ability to imagine the solid geometries and represent the views in a two dimensional space.*	**12-14**
	Contents: **Projection of Planes:** Projection of Triangular, Square, Rectangular, Pentagonal, Hexagonal or Circular planes inclined to either HP or VP only. **Projection of Solids:** Solid projection (of Prism, Pyramid, Cylinder, Cone only) with the axis inclined to HP or VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method. **Section of Solids:** Section of Prism, Pyramid, Cylinder and Cone cut by plane perpendicular to at least one reference plane and incline to other in simple positions of the solid. (Section in initial position only)	

	Task 1: Projection of Planes: Draw the true shape of a flat surface such as a triangle, pentagon, hexagon or circle, when it is inclined to one or both principal planes, by using auxiliary views to reveal its actual dimensions.	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply fundamental engineering concepts to construct auxiliary views that reveal the true shape and dimensions of inclined planes such as triangles, pentagons, hexagons, and circles by selecting and justifying appropriate projection methods. (P.I.-1.3.1, P.I.-2.2.3)*	
	Task 2: Projection of Solids: Draw the orthographic projection of three-dimensional objects like prisms, pyramids, cylinders, and cones whose axes are inclined to the reference planes to capture their true orientations.	
	Learning Outcomes: *A learner will be able to* *LO 5.2: Apply fundamental engineering concepts to generate orthographic projections of prisms, pyramids, cylinders, and cones with inclined axes by employing change-of-position and auxiliary-plane methods, and compare these approaches to select the most accurate representation.* (P.I.-1.3.1, P.I.-2.2.4)	
	Task 3: Section of Solids: Draw sectional orthographic projections of solid (e.g., prism, pyramid, cylinder, or cone) with a plane perpendicular to one reference plane and inclined to another, to expose its internal features, and then illustrating the cut surface in an orthographic section view with appropriate hatching.	
	Learning Outcomes: *A learner will be able to* *LO 5.3: Apply mechanical engineering concepts to produce sectional orthographic projections of solids cut by planes inclined to reference planes with correct hatching, annotations, and dimensions; employ justified approximations to resolve complex orientations; and produce clear technical notes with standardized symbols. (P.I.-1.4.1, P.I.-2.2.3, P.I.-9.1.2, P.I.-9.3.1)*	
		Total **60**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve engineering problems.
1.2.1	Apply laws of natural science to an engineering problem
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply mechanical engineering concepts to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.1	Identify standard procedures and justified assumptions applicable to problem-solving.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solution processes to select the best process.

5.1.1 Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities

5.2.2 Demonstrate proficiency in using discipline specific tools.

9.1.2 Produce clear, well-constructed, and well-supported written engineering documents.

9.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations.

Course Outcomes: A learner will be able to -

1. Apply mathematical and engineering principles and CAD software tools to produce, annotate, and document precise 2D engineering drawings by selecting correct line types, scales, dimensioning practices, and IS-standard conventions to generate professional-quality figures. *(LO1.1)*
2. Apply projection principles and CAD techniques to produce accurate orthographic and sectional views by converting isometric drawings into orthographic and sectional projections with appropriate hatching, and annotations per IS standards. *(LO2.1, LO2.2)*
3. Apply engineering principles to interpret orthographic projections and develop isometric views from orthographic projections by applying geometric visualization and CAD commands. *(LO3.1)*
4. Apply fundamental and natural science principles and analyze orthographic and sectional projections to identify and reconstruct missing views by decomposing drawings into sub-problems and employing CAD tools to generate accurate third and sectional projections. *(LO4.1)*
5. Apply natural science and engineering principles to create true-shape auxiliary views of inclined planes, orthographic projections of solids with inclined axes, and sectional views with correct hatching and annotations using auxiliary-plane and change-of-position methods to ensure accuracy. *(LO5.1, LO5.2, LO5.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESL204.1	3	-	-	-	3	-	-	-	3	-	-
ESL204.2	3	3	-	-	3	-	-	-	3	-	-
ESL204.3	3	3	-	-	3	-	-	-	3	-	-
ESL204.4	3	3	-	-	3	-	-	-	3	-	-
ESL204.5	3	3	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	-	-	**3**	-	-	-	**3**	-	-

Text Books :

1. Engineering Drawing (Plane and solid geometry), N.D. Bhatt, 54th Edition, 2023, Charotar Publishing House Pvt. Ltd.
2. Engineering Drawing, N.H.Dubey, 16th Edition, 2015, Nandu Publications

3. Machine Drawing, N.D. Bhatt & V.M. Panchal, 49th Edition, 2014, Charotar Publishing House Pvt. Ltd.

Reference Books :

1. Engineering Drawing, Narayana, K.L. & P Kannaiah ,3rd Edition, 2012, Scitech Publisher
2. AutoCAD 2024: A Problem-Solving Approach, Basic and Intermediate, , Prof. Sham Tickoo, 30th Edition, 2023, CADCIM Technologies

Other Resources :

1. NPTEL Course: Engineering Drawing by Prof. P.S. Robi, Department of Mechanical Engineering, IIT Guwahati:-Web link- https://nptel.ac.in/courses/112103019.
2. NPTEL Course: Engineering Graphics and Design by Prof. S.R.Kale, Department of Mechanical Engineering, IIT Delhi :-Web link- https://onlinecourses.nptel.ac.in/noc21_me128

In-Semester Assessment (50 Marks)

1. **AutoCAD Assignments (10 Marks):** AutoCAD assignments will be evaluated as a part of continuous laboratory experiments which will be done in AutoCAD software. The Assignments will be based on the following topics:
    i. Redraw the given views using basic AutoCAD Commands. (2 Problems)
    ii. Orthographic Projections (2 Problems)
    iii. Sectional Orthographic Projections (2 Problems)
    iv. Isometric Projections (3 Problems)
    v. Reading of Orthographic Drawings (1 Problems)
2. **Sketchbook Assignments (10 Marks)*:*** Regular Assignments will be given based on the topic covered in the class and will be evaluated at regular intervals as a part of continuous assessment. The Assignments will be based on the following topics:
    1) Projection of Lines (2 Problems)
    2) Orthographic Projections (2 Problems)
    3) Sectional Orthographic Projections (2 Problems)
    4) Reading of Orthographic Projections (1 Problems)
    5) Isometric Projections (2 Problems)
    6) Projection of Planes (2 Problems)
    7) Projections of Solids (2 Problems)
    8) Section of Solids (2 Problems)
3. **Regularity and active participation: 5 marks**

4. **Laboratory Tests (25 Marks):**

   A. **AutoCAD Exam (15 Marks):** The test will be based on Orthographic Projections on AutoCAD software.

      Evaluation Criterion:

      1. Completion and accuracy of the drawing.
      2. Presentation of labels, dimensions, title block on the sheet.

   B. **Manual Drawing Lab Exam (10 Marks):** The test will be based on projections of lines and projections of Solids.

      Evaluation Criterion:

      1. Completion and accuracy of the drawing.
      2. Neatness of the drawing.
      3. Proper space management of the sheet.

End Semester Examination (50 Marks)

Topics for the End Semester Practical Examination (AutoCAD) (2.5 hours)

1. **Isometric drawing. (1 problem) (20 Marks) (Excluding the curves on an inclined plane):**

   The two-dimensional views will be provided such as Front view, Top View and Side view of the object. The task will be to convert the given views in to an isometric drawing (three-dimensional model)

2. **Sectional Orthographic Projection (1 problem). (15 Marks):**

   An isometric figure will be given and the task will be to convert the isometric figure in a sectional 2D view which will include the sectional Front view, Top View and Side view of the three-dimensional figure.

3. **Reading of Orthographic Projections (1 problem) (15 Marks):**

   The two views of the object will be given as an orthographic views and the task will be to draw the missing view of the given object.

Note:

1. Printout of the answers have to be taken preferably in A4 size sheets and should be assessed by External Examiner only.

2. Knowledge of Auto CAD software, concepts of Engineering Graphics related to specified problem and accuracy of drawing should be considered during evaluation.

Two examiners, one Internal and one External will do the evaluation

Course Type	Course Code	Course Name	Credits
ESL	ESL205	PROGRAMMING LABORATORY-II (JAVA)	02

Examination Scheme		
Continuous Assessment	**End Semester Exam(ESE)**	**Total Marks**
50	50	100

Pre-requisite:

1. ESL103: Programming Laboratory-I (C)

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering tool usage
4. PO11: Life-long learning

Course Objectives:

1. To impart the knowledge in object-oriented paradigm in the Java programming language.
2. To inculcate the importance of Classes & objects along with constructors,
3. To impart skills of inheritance, interface and packages and demonstrate the concept of reusability for faster development.
4. To introduce usage of Exception Handling, Multithreading, Input Output streams in variousapplications.
5. To impart the knowledge of designing, implementing, testing, and debugging graphical user interfaces in Java using applets.

Module	Details	Hrs.
	Course Introduction Java is platform independent, open-source object oriented programming language enriched with free and open source libraries. In current industrial scenario Java has the broad industry support and is prerequisite with many allied technologies like Advanced Java, Java Server Pages, and Android Application Development. Thus, current industrial trends necessitate acquiring Java knowledge for graduates.	**01**
01.	**Introduction to Java** ***Learning Objective:*** *Learner is expected to gain proficiency in concept of programming tokens like variables, data types, operators, control structures, function. Also expected to apply the concepts for writing program*	
	Contents: Java Architecture, Language Basics: Path, class path, command line argument, keywords, basic data types and types of operators, Flow control Statements: if, if-else, nested if, switch, while, do-while, for, enhanced for, break and continue, Arrays: one- and two-dimensional array **Task 1:** Write a Program that accepts two Strings as command line	**11**

	arguments and generate the output in the required format. Example: If the command line arguments are ABC and Mumbai then the output generated should be: ABC Technologies Mumbai [Note: It is mandatory to pass two arguments in command line] *LO 1.1: The learner will be able to implement command-line argument handling in Java and apply basic input validation to generate formatted output (P.I. -1.3.1, P.I.-1.4, 1 P.I. -5.1.1, P.I. -5.1.2)* **Task 2**: (Any one task) **a.** Write a program to check if a given integer number is odd or even **b.** Write a program to accept gender ('Male' or 'Female') and age from command line arguments and print the percentage of interest based on the given conditions. If the gender is 'Female' and age is between 1 and 58, output is 8.2%. If the gender is 'Female' and age is between 59 and 100, the output is 9.2%. If the gender is 'Male' and age is between 1 and 58, the output is 8.4%. If the gender is 'Male' and age is between 59 and 100, the output is 10.5%. *LO 1.2: Learners will be able to apply language basics and conditional logic in Java to solve basic decision-making problems (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)* **Task 3:** Write a program to initialize an integer array and print the sum and average of the array. *LO 1.3: Learners will be able to implement array operations in Java to compute and validate results (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)*	
02.	**Class and object** ***Learning Objective:*** 1. *Learner is expected to gain knowledge of class, object. Also expected to write program using class and object.* 2. *To grasp the fundamental concept of input output. Also expected to write program using different input output constructs.*	**08**
	Contents: Classes, objects, Abstraction, Encapsulation, Polymorphism, Input and output functions in Java, scanner class **Task 4:** Create a simple Java class representing an entity Person with attributes like id, name, contact number and instantiate the objects of the class. *LO 2.1: A learner will be able to apply fundamental concept of class and objects and take input from user and identify attributes and methods to implement java program using IDE like eclipse to validate the result. (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)* **Task 5:** Create a student class with private variables roll no and marks. Write getter and setter methods to take user input and display. *LO 2.2: A learner will be able to apply fundamental concept of encapsulation and identify private variables and methods to implement java program using IDE like eclipse to validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –*	

	2.4.1, P.I. -5.1.1, P.I. -5.1.2) **Task 6:** Write a Java program that initializes variables using constructors and prints out information about entity (eg. Student) *LO 2.3: A learner will be able to apply fundamental concept of constructors and take input from user and identify attributes and methods to implement java program using IDE like eclipse to validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)*	
03.	**Inheritance, Interfaces, Packages** ***Learning Objective:*** 1. *Learner is expected to gain knowledge of code reusability. Also expected to write program using inheritance.* 2. *Learner is expected to grasp the concept of multiple inheritance Also expected to apply interface concept to achieve multiple inheritance.* 3. *Learner is expected to gain the knowledge in concept of grouping related classes, interfaces, and sub-packages. Also expected to apply the concept of packages to write well-structured application.*	**16**
	Contents: Types of inheritance, Method overriding, super, Abstract class and abstract method, final, Interface. Define package, types of package, naming and creating packages.accessing package. **Task 7:** Create a program to manage employee details using where Base class Person should store name and age, while the derived class Employee should store details such as employee ID and department. *LO 3.1: A learner will be able to apply fundamental concept of inheritance and identify the variables and inherit the features of one class and adapt IDE like eclipse to implement java program and validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)* **Task 8:** Develop a program to calculate the area of different shapes using an interface. Define an interface Shape with a method calculate_area(). Implement this interface in two classes: Rectangle and Circle. *LO 3.2: A learner will be able to apply fundamental concept of interface and identify the variables and use multiple inheritance and adapt IDE like eclipse to implement java program and validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)* **Task 9:** Create user defined package for the given problem. *LO 3.3: A learner will be able to apply fundamental concept of packages and adapt IDE like eclipse to implement java program and validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -2.1.2, P.I. –2.4.1, P.I. -5.1.1, P.I. -5.1.2)*	
04.	**Exception Handling and Multi-threading** ***Learning Objectives:*** 1. *To impart skills that can enable students to check and handle the proper functioning of applications. Also expected to apply the exception handling for proper functioning of applications.* 2. *Learner is expected to know the concept of multithreading. Also expected to apply it for multitasking.*	**08**
	Contents:	

	Exception handling using try, catch, finally, throw and throws, Multipletry and catch blocks, user defined exception. Thread lifecycle, thread class methods, creating threads using extends andimplements keyword. **Task 10:** Write a program for handling the given exception using try, catch, finally, throw and throws. *LO 4.1: A learner will be able to apply concept of exception handling and adapt IDE like eclipse to implement java program and validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -5.1.1, P.I. -5.1.2)* **Task 11:** Create threads to run the given multiple processes in the given program. *LO 4.2: A learner will be able to apply concept of threads and adapt IDE like eclipse to implement java program and validate the result (P.I. -1.3.1, P.I. -1.4.1, P.I. -5.1.1, P.I. -5.1.2)*	
05.	**Graphical User Interface** ***Learning Objective/s:*** 1. *Learner will gain the knowledge of handling events through GUI. Also expectedto apply it for creating small applications.* 2. *Learner is expected to develop proficiency in the concept of swing. Also expected to apply it for developing GUI with good look and feel* 3. *Learner will learn the concept of connecting database with business logic. Alsoexpected to apply it for retrieving and saving data.*	**16**
	Contents: Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class.Introduction to JDBC, JDBC-ODBC connectivity **Task 12:** Develop a program for GUI using appletExample *LO 5.1: A learner will be able to apply concept of GUI and adapt IDE like eclipse to implement java program and validate the result, illustrate path from CLI to GUI and summarize the advantages of GUI (P.I. -1.3.1, P.I. -1.4.1, P.I. -5.1.1, P.I. -5.1.2, P.I. -11.2.1, P.I. -11.2.2)*	
	Course Conclusion	
	Total	**60**

Self-Learning Topics

- **Micro-projects**
  A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:
  1. Mini Banking System for handling deposits and withdrawal.
  2. Medical Store Stock Management System.
  3. Bus Reservation System.

4. Student Information System
5. Library Management System
6. Attendance Management System.

Guidelines for developing micro projects:

1. Declare four to five classes and may include Interfaces if required.
2. Must use Most of the Object Oriented Concepts.
3. Must implement concepts of Inheritance and Exception Handling.
4. Must Create Own Package.
5. May use the constructor overloading and overriding.
6. May Use Multithreading if required.

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply computer science concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.4.1	Able to apply computer engineering principles to solve the problems
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
11.2.1	Identify historic points of technological advance in engineering that required practitioners toseek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep currentregarding new developments in your field

Course Outcomes: A learner will be able to -

1. Install java environment and write a java program using fundamental concepts. *(LO 1.1, LO 1.2, LO 1.3*)
2. Apply concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem*(LO 2.1, LO 2.2, LO 2.3*)
3. Achieve reusability in programming by using concept of Inheritance, Interface and Packages. *(LO 3.1, LO 3.2, LO 3.3*)
4. Implement concept of Multithreading, and exceptions to obtain robust and faster programmed solutions to problems. *(LO 4.1, LO 4.2*)
5. Design and develop application using Abstract Window Toolkit, Swings with database connectivity *(LO 5.1*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESL205.1	3	3			3						
ESL205.2	3	3			3						
ESL205.3	3	3			3						
ESL205.4	3				3						
ESL205.5	3				3						3
Average	3	3			3						3

Text Books :

1. Java: The Complete Reference, Herbert Schildt, Ninth Edition, 2017, McGraw Hill Education.
2. Programming with Java, E. Balagurusamy, Seventh Edition, 2019, McGraw Hill Education

Reference Books :

1. Beginning JAVA, Ivor Horton, Seventh Edition, 2011, Wrox.
2. JAVA Programming Black Book, by D.T. Editorial Services, 2015, Dreamtech Press.
3. Java One Step Ahead, Anita Seth, B.L.Juneja, First Edition, 2017, oxford university press.

Other Resources :

1. NPTEL Course: Programming in Java, By Debasis Samanta, Computer Science and Engineering, Indian Institute of Technology Kharagpur.:-Web link- https://onlinecourses.nptel.ac.in/noc23_cs74/co
2. Web link-www.w3schools.com
3. Web link-www.tutorialspoint.com

IN-SEMESTER ASSESSMENT (TERM WORK) (50 MARKS)

1. Task Execution (30 Marks)

Students will be given minimum 12 experiments.
Students are expected to

1. Identify variables, data types methods/approach required to write the code for the given task and apply the same.
2. Execute given task for different inputs and verify the result
3. Create a simple Java class representing an entity (e.g., Person, Car) with attributes and methods. Instantiate objects of the class and demonstrate basic operations.
4. Apply simple inheritance and multilevel inheritance.
5. Import a Java Built-in API package and also create user's own package
6. Handle the proper functioning of applications by applying the exception handling.
7. Develop proficiency in the concept of applet and apply it for creating small applications (GUI)

Students are evaluated based on following:

1. Logic building for the given task (10 marks)
2. Rectifying logical errors and syntax errors (06 marks)
3. Well-structured and organized program (06 marks)
4. Verification of experiment output for different inputs (08 marks)

Refer the sample task given below.
Example:

Create a Persona class to add details of the person, inherit features of person class into Employee class and display details using method.
Students are expected to.

1. Identify Variables, data types methods/approach required to create teacher class and add methods to display details of a given teacher
2. Execute given task for different inputs and verify the result
3. Follow the coding standards
4. Identify errors and rectify the errors.

2. Regularity and active Participation (05 Marks)

3. Mid Semester Examination (15 Marks)

a) Task Execution: 10 Marks

Students are evaluated based on following:

1. Logic building for the given task (04 marks)
2. Rectifying logical errors and syntax errors (02 marks)
3. Well-structured and organized program (02 marks)
4. Verification of experiment output for different inputs (02 marks)

b) Oral: 05 Marks

END SEMESTER EXAMINATION (Practical & Oral Exam) (50 Marks)

1. Task Execution: 15 Marks
   Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned in continuous evaluation
2. Presentation of Results and conclusion, Inferences drawn: 05 Marks
3. Multiple Choice Questions based on entire syllabus: 15 Marks
4. Oral: 15 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
ESL	ESL 206	BASIC ELECTRONICS ENGINEERING LABORATORY	02

Examination Scheme		
Continuous Assessment	**End Semester Exam(ESE)**	**Total Marks**
25	25	50

Pre-requisite:

1. ESC102- Basic Electrical Engineering
2. BSC102- Engineering Physics I

Program Outcomes addressed:

1 PO2: Problem Analysis
2 PO3: Design / Development of Solutions
3 PO4: Conduct investigations of complex problems
4 PO5: Modern tool usage
5 PO6: The engineer and society
6 PO8: Individual and Team work
7 P09: Communication
8 P11: Life-long learning

Course Objectives:

1. To familiarize with electronics components, measuring devices, source devices for building and analyse analog/digital circuits
2. To provide practical exposure to sensors and transducers and build a basic data acquisition system
3. To provide hands-on experience in designing real time application circuits.

Module	Details	Hrs.
	Course Introduction Electronics is pervasive in the modern era which provides a platform to comprehend the basics of components, ICs devices with some practical application. This provides a roadmap to venture in the field of electronics. The electronic circuits form the integral part for almost all used in industrial machinery, computers, microprocessors, household appliances, medical equipment, internet and e-commerce.	**01**
01.	**Electronic Devices (Expected to perform all)** ***Learning Objective:*** ***Learner is expected to analyze experimental results to validate theoretical concepts and understand practical implications. Evaluate circuit parameters to achieve desired performance characteristics.***	
	Contents: **Experiment 1: Study of CRO & Measurement of Voltage Amplitude & Frequency.** *LO 1.1: A learner will be able to identify the features of CRO and able to measure the amplitude and frequency for a specific signal source and extract desired understanding and conclusions consistent with objectives in a team. (P.I. - 1.3.1, P.I-2.4.4, P.I-8.3.1, P.I-11.1.3)*	**8**

	Experiment 2: Testing of Components using Instruments and fault detection. *LO 1.2: A learner will be able to identify the components, apply the relevant knowledge, measure the values manually and validate it with the help of instruments. (P.I. – 1.4.1, P.I. - 2.1.3, P.I.-2.4.2)* **Experiment 3: V.I Characteristics of Si or Ge and Zener Diode** *LO 1.3: A learner will be able to identify the important features of the electronic device through data sheets and interpret the VI graph to determine the diode parameters like knee voltage, saturation current etc.in a team to access new source of information. (P.I. – 1.4.1, P.I.-2.3.2, P.I. – 4.1.4, P.I-8.1.1, P.I-11.3.1)* **Experiment 4: Applications of Diode – Clipper/Clamper/Rectifiers** *LO 1.4: A learner will be able to identify the working principles of diode-based clipper, clamper, and rectifier circuits, correctly interprets results and relates them to circuit structure uses CRO/multimeter to take accurate measurements and documents the results in the form of waveforms. (P.I. – 1.4.1, P.I.-2.3.2, P.I. – 4.1.4, P.I-8.1.1, P.I-11.3.1).* **Experiment 5: Characteristics of BJT in Common Emitter Configuration.** LO 1.5: *A learner will able to identify the proper choice of devices with given specifications, uses voltmeter/ammeter/CRO to take correct readings at various bias levels and accurately plot graph in a team. (P.I. – 1.4.1, P.I.-2.3.2, P.I. – 4.1.4, P.I-8.1.1, P.I-11.3.1).*	
02.	**Digital Circuits (Any 3)** ***Learning Objective:*** *Learner is expected to recall basics of Digital Circuit Design. Also expected to apply it to solve any Boolean expression.*	**8**
	Contents: Experiment 6: Introduction to Logic Gates – NOT, AND, OR, NAND NOR and XOR. *LO 2.1: A learner will be able to identify and analyze various IC's required for a digital system, use systematic techniques to test and verify with the help of truth table as a team. (P.I- 1.3.P.I.-2.4.1, P.I.-8.3.1)* **Experiment 7: For a given Boolean expression, design and verify the circuit using Universal Gates.** *LO 2.2: A learner will be able to identify the ICs required for the design for given specifications, devise a best fitting design solution, verify a given Boolean expression and validate the theoretical results with hardware in a team or make an attempt to independently tackle the problem with the help of instructor materials. (P.I- 1.4.1, P.I-2.4.2, P.I.- 3.3.3, P.I.- 9.3.1, P.I-11.1.3)* **Experiment 8: Basics of AND gate and its application in car wiper control** **Experiment 9: Basics of NOT gate and its application in fuel level Indicator.** *LO 2.3: A learner will be able to identify the ICs required for the above given application, devise a best fitting design solution, verify a given Boolean expression and validate the theoretical results with hardware in a team or find the gap on using the particular IC and close the gap. (P.I- 1.4.1, P.I-2.4.2, P.I.- 3.3.3, P.I.- 9.3.1, P.I-11.1.2)*	
03.	**Sensor/ Transducer Applications (Any one)** ***Learning Objective:***	**4**

	Learner is expected to know ***the fundamentals of sensor/transducer and model or trouble shoot the basic data acquisitionsystem.***	
	Contents: Sample List 1. Intruder detection using IR sensor 2. Collision avoidance using ultrasonic sensor 3. Fire alarm system using temperature sensor 4. Movement detection using flex sensor 5. Light detection using LDR 6. Interactive doorbell system using Proximity sensor 7. Gas detection using gas sensors *LO 3.1: A learner will be able to identify and analyze various sensors required for a particular application, breakdown the problem into sub parts collect the data, test, check/troubleshoot for the working, sustainability and verify with the help of equipment's ((CRO, multimeter) as a team. (P.I- 1.3.P.I.-2.2.1, P.I-4.3.1, P.I-6.3.1, P.I.-8.3.1, , P.I.-9.3.1, P.I-11.1.3)*	
04.	**Real Time Applications (Any one)** ***Learning Objectives:*** *Learner is expected to* develop practical electronic skills through designing and implementing real-lifeapplications..	**8**
	Contents: Sample List 1. Regulated Power Supply using transistor and zener diode 2. Electronic lock using basic logic gates 3. Cockpit warning light control using basic logic gates. 4. Universal NOR gate and its application in automobile alarm system 5. Universal NAND gate and its application in level monitoring inchemical plant 6. Mosquito Trap bat. 7. Electronic safety lock using vibration sensor 8. Water Level Indicator 9. Smoke Detector 10. Smart Trash Bin 11. Virtual Piano 12. Voltage Doubler Circuit *LO 4.1: The learner will be able to recognize any real time application which can be one of the above or of own interest, that is only to test with software/hardware, their troubleshooting skills in implementing the simple real-life applications in a team and identify and solve the gap if required. (P.I- 1.4.1,.P.I.-2.2.1, P.I-4.3.1, P.I-5.3.3,P.I-6.3.1, P.I.-8.3.1,P.I.- 9.3.1, P.I-11.3.1)*	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.

1.4.1	Apply concepts of electronics and communication engineering and accepted practice areas to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.1	Breakdown complex problem into interconnected sub parts and analyse by proper assumptions/ justification from information and resources.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.3.3	Identify relevant data from the given resources and arrive at a best fitting design solution for particular specifications.
4.1.4	Establish a relationship between measured data and underlying physical principles.
4.3.1	Use appropriate procedures, tools, and techniques to conduct experiments and collect data
5.3.3	Recognize sources of error in measurements, modelling or simulations and verify credibility of results.
6.1.1	Recognize sources of error in measurements, modelling or simulations and verify credibility of results.
6.3.1	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to –

1. Apply knowledge about the electronic equipment such as oscilloscopes, function generators, multimeter, timers etc. for analog testing, measuring the parameters electronics devices such as diode, Zener diode, Transistor etc (*LO 1.1, LO 1.2, LO1.3, LO1.4, LO1.5*)
2. Demonstrate and analyze the use of basic gates and apply it in various applications in digital domain. (*LO 2.1, LO 2.2, LO 2.3*)
3. Analyse sensors/transducers and assemble a prototype for a basic data acquisition system. (*LO 3.1*)
4. Design analyse, test, and ensure functionality of real-life electronic applications using acquired skills and electronic test instruments. (*LO 4.1)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ESL206.1	3	3		3				3			3
ESL206.2	3	3	2	3				3			3
ESL206.3	3	3		3		2			2		3
ESL206.4	3	3	2	3		2			2		3
Average	3	3	2	3		2			2		3

Text Books:

1. Basic Electronics By B.L.Theraja,S Chand Publications.
2. Basic Electronics Engineering. Satya Sai Srikant, Prakash Kumar Chaturvedi, Springer, Year:2020
3. A Textbook of Basic Electronics, Dr. Barun RayChaudhuri Chhaya Prakashan Pvt. Ltd.

Reference Books :

1 Learning Art of Electronics: A Hands-on Lab Course By. Paul Horowitz and Thomas, C. Hayes, 2020

2 Basic Electronics--theory and practice J. A. Sam Wilson, Publisher, Gregg Division,McGraw-Hill, 1977.

3 Practical Electronics for Inventors, 4th Edition by Paul Scherz, Simon Monk, 2016

4 Getting started in Electronics – Forest M. Mims Publisher. Fort Worth: Radio Shack,12th edition, 1994.

5 Self-teaching guide: All new electronics – Harry Kybett and Earl Boysen, 3rd edition 2008.

Other Resources :

1. Basic Electronics Course – NPTEL By Dr. M.B. Patil, IIT Bombay.
2. Virtual Lab of Basic Electronics. Basic Electronics (iitkgp.ac.in).

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(25 Marks)

1. Lab Experiments: 10 Marks
2. Internal Assessment:
   i. Practical Test 1 (Based on 50% of the Practical list): 5
   ii. Practical Test 2 (Based on remaining 50% of the Practical list):5
3. Regularity and active participation: 5 marks

END SEMESTER EXAMINATION (Pract. /Oral Exam) (25 Marks)

Performance of experiments based on the course content.

Students will have to:

1. Draw the circuit diagram.: 03 Marks
2. Identify the components.: 01Marks
3. Make proper connections on breadboard.:03Marks
4. Take accurate readings from instruments.:03 Marks
5. Tabulate the readings and plot graphs if required.:05 Marks
6. Orals:10 Marks

Two examiners, one Internal and one External will do the evaluation

Course Type	Course Code	Course Name	Credits
SEC	SEC202	BASIC WORKSHOP PRACTICE II	01

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
50	--	50

Pre-requisite:

1. SEC101- Basic Workshop Practice I

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO5: Engineering tool usage
3. PO6: The engineer and the world
4. PO8: Individual and collaborative team work
5. PO11: Life-long learning

Course Objectives :

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labour.
3. To get exposure to interdisciplinary engineering domain.

Module	Detailed Contents	Hrs
	Course Introduction The Workshop Practice II course is intended to give students with the core information and abilities required for developing engineering skill sets and getting an exposure to work in an interdisciplinary engineering domain including basic electronic work shop. This hands-on course introduces the fundamental principles, equipment, and techniques utilised in workshop scenarios, such as carpentry, sheet metal working, brazing and forging.	**01**
01.	***Learning Objectives:*** *1. To gain proficiency in accurate measuring, marking, and layout techniques, including the use of squares, levels, and other layout tools.* *2. To develop proficiency in the use of basic carpentry hand tools such as hammers, saws, chisels, planes, and measuring devices.*	**09**
	Content: Carpentry • Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood turning and modern wood turning methods. • Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning.	
	Learning Outcomes :	

	A learner will be able to *LO1.1: Accurately measure and layout components of carpentry projects using appropriate tools and techniques, ensuring precision and alignment. (P.I. - 1.3.1, 5.2.1, 11.3.1)* *LO1.2:Exhibit proficiency in the use of common carpentry hand tools and power tools, including accurate handling, operation, and maintenance. (P.I. - 1.4.1, 5.2.2, 11.3.2)*	
02.	***Learning Objectives:*** *1. To provide hands-on experience in measuring instruments, electronic components, PCB circuit design and to familiarize students with PCB fabrication process.* *2. To provide hands-on experience in assembly and testing of electronics circuit.*	**10**
	Content: Basic Electronic work shop • Introduction to measuring instruments and electronic components like resistors, capacitors, inductors, diodes, transistors, etc. • Demonstration of PCB simulation software for making the layout, layout transfer to PCB, etching, drilling and soldering technique. • Assembling and testing the circuit for correct functionality.	
	Learning Outcomes : *A learner will be able to* *LO2.1: Select appropriate electronic components based on design requirements and place them effectively on the PCB layout. (P.I. - 5.2.1, 5.2.2, 11.3.1)* *LO2.2: Demonstrate a clear understanding of what PCBs are, how they function, and their importance in electronic devices and systems. (P.I. - 8.2.1, 8.3.1)* *LO2.3: Comprehend the basic principles of PCB design, including component placement, routing, signal integrity, and manufacturability. (P.I. - 6.1.1, 6.4.2, 8.2.1, 8.3.1, 11.3.2)*	
03.	***Learning Objectives:*** *1. To become proficient in the use of various sheet metal working tools and equipment, such as shears, brakes, punches, rollers, and spot welders.* *2. To grasp the fundamental principles and techniques involved in forging, which includes heating, shaping, and cooling metal through the application of force.*	**10**
	Content: Sheet metal working, Brazing and Forging (Smithy) • Use of sheet metal, working hand tools, cutting, bending, spot welding. One job covering maximum operation with soldering or brazing. • At least one forging job to be demonstrated and a simple job to be made for Term Work in a group of 4 students.	
	Learning Outcomes : *A learner will be able to* *LO3.1: Use various sheet metal working tools and equipment proficiently. (P.I. - 5.2.2, 5.3.2, 11.1.1, 11.3.2)* *LO3.2: Demonstrate competence in operating forging equipment and tools, including heating furnaces, power hammers, presses, and hand tools, to manipulate metal effectively. (P.I. - 5.2.2, 8.1.1, 8.3.1, 11.1.1, 11.3.2)*	

Performance Indicators:

P.I. No. **P.I. Statement**

1.3.1 Apply fundamental engineering concepts to solve engineering problems

1.4.1 Apply Mechanical engineering concepts to solve engineering problems.

5.2.1 Identify the strengths and limitations of tools for creating engineering designs.

5.2.2 Demonstrate proficiency in using discipline-specific tools.

5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.

6.4.2 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.

8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.

8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.

11.1.1 Describe the rationale for the requirement for continuing professional development.

11.3.1 Source and comprehend technical literature and other credible sources of information.

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes :

A learner will be able to

1. Develop the necessary skill required to handle/use different carpentry tools. (*LO 1.1*, *LO 1.2*)
2. Identify different electronic components to design, fabricate and assemble PCB. (*LO 2.1*, *LO 2.2*, *LO 2.3*)
3. Develop the necessary skill required to use different sheet metal and brazing tools. (*LO 3.1*)
4. Demonstrate the forging operation with the help of a simple job. (*LO 3.2*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
SEC202.1	3				3						3
SEC202.2					3	3		3			3
SEC202.3					3			3			3
SEC202.4					3			3			3
Average	3				3	3		3			3

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Continuous Internal Assessment (CIA) - (50 Marks)

Job Work with complete workshop book: 40 Marks

Attendance and Active participation: 10 marks

G. Second Year Syllabi

Course Type	Course Code	Course Name	Credits
PCC	ECPCC301	Engineering Mathematics-III	03+01*

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20 + 25*	30	50	1.5	2	125

*For Tutorial

Pre-requisite :

1. BSC101 Engineering Mathematics-I
2. BSC204 Engineering Mathematics-II

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis

Course Objectives :

1. To provide the basic knowledge on the concept of various Mathematical transforms.
2. To introduce the concept of Complex Variables and its applicability in the field of Engineering.

Module	Details	Hrs	CO
	Course Introduction Engineering mathematics and transforms are indispensable tools in EXTC engineering, enabling engineers to analyze signals, systems, and data in various domains such as signal processing, communications, control systems, imaging, and data analysis. For example- 1. Application of Laplace Transforms in Engineering Problems. 2. Application of Fourier Series and Transform in Spectrum analysis. 3. Application of Complex and Analytic functions in Control Theory.	**01**	--
01.	**Laplace Transforms.**	**06-08**	CO- 1
	Learning Objective/s:		
	The learner will be able to analyze standard Laplace Transforms using basic definitions and apply its knowledge to solve mathematical problems.		
	Contents:		
	Definition of Laplace Transforms, Condition of existence of Laplace Transform, Laplace Transforms of standard functions: $e^{at}, sinat, cosat, sinhat, coshat, t^n\ n > 0.$ Properties of Laplace Transform: Linearity, First Shifting Theorem, Change of scale Property, Multiplication by t , Division by t. Laplace Transform of derivatives and integrals, Heaviside's Unit Step function.		
	Self-Learning Topics:		
	Second Shifting Theorem, Laplace Transform of Periodic functions.		
	Learning Outcomes :		

	A learner will be able to *LO 1.1: Interpret standard Laplace transforms and apply it for finding Laplace transform of mathematical problem. (P.I.- 1.1.2)* *LO 1.2: Apply advanced techniques of factorization to solve Laplace Transform problems having higher order terms. (P.I.- 1.1.3)* *LO 1.3: Identify discontinuous functions and apply Heaviside's unit step transform to compute the transforms. (P.I-2.1.2)* *LO 1.4: Identify whether shifting or scaling property is to be used based on the nature of mathematical problem. (P.I.-2.1.3)*		
02.	**Inverse Laplace Transform.** ***Learning Objective/s:*** *Learner will be able to analyze and apply the techniques of Laplace and inverse Laplace transform to solve differential equations.* **Contents:** Definition of Inverse Laplace Transform, Properties of Inverse Laplace Transform: Linearity, Shifting Theorem, Finding Inverse Laplace Transform: Method of partial fraction, Differentiation Property. Convolution Theorem (without proof), Solution of Differential equations-initial value problem and Boundary Value Problem. ***Self-Learning Topics:*** *Application of Initial and Final Value Problem in EXTC Engineering.* ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Interpret standard Inverse Laplace transforms and its applicability to a given mathematical problem. (P.I.-1.1.2)* *LO 2.2: Apply advanced computation techniques to solve initial and boundary value problems of differential equation. (P.I.-1.1.3)* *LO 2.3: Identify whether differentiation property or Convolution theorem is to be applied based on the nature of the Inverse Laplace mathematical problem. (P.I.-2.1.3)* *LO 2.4: Identify whether linear, repeated or quadratic type of partial fraction method is to be used to find Inverse Laplace transform. (P.I.-2.1.2)*	**06-08**	CO- 1
03.	**Fourier Series** ***Learning Objective/s:*** *To analyze various wave forms and use the knowledge of periodic wave forms in determining a function in terms of its sine and cosine counterparts.* **Contents:** Dirichlet's conditions, Definition of Periodic function and graphical representation of periodic function: sine wave form, cosine wave form, square wave form, saw tooth wave form, Definition of Fourier series, Fourier series of periodic function with period 2π and Fourier series of periodic function with period $2l$, Fourier series of even and odd functions, Half range Sine and Cosine Series. ***Self-Learning Topics:*** *Parseval's Identity, Complex form of Fourier Series*	**07-09**	CO- 2

	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply mathematical techniques of algebra and calculus in determining Fourier coefficients. (P.I.-1.1.1)* *LO 3.2: Apply fundamental concept of Series and summation to find Fourier series expansion of the periodic function. (P.I.-1.3.1)* *LO 3.3: Articulate and interpret the basics of periodic functions and series. (P.I.-2.1.1)* *LO 3.4: Analyze waveforms and use this information to identify periodic functions. (P.I.-2.1.3)*		
04.	**Fourier Transform** ***Learning Objective/s:*** *Learner will be able to apply the concept of Fourier transform to convert and analyze a function in a form that describes frequencies present in the original function.* **Contents:** Fourier Integral Theorem, Definition of Fourier Transform, Fourier transform of even and odd function, Properties of Fourier Transform: Linearity, scaling and shifting. Fourier Transform of derivatives, Inverse Fourier Transform. ***Self-Learning Topics:*** *Convolution theorem. Fourier sine transform, Fourier cosine transform* ***Learning Outcomes :*** *A learner will be able to* *LO 4.1: Identify the correct properties of Fourier Transform applicable to a given problem and use it for solving advanced mathematical problems. (P.I.-2.1.3)* *LO 4.2: Apply the concept of calculus for finding frequencies present in a function using Fourier Transform. (P.I.-1.1.1)* *LO 4.3: Synthesize information about the waveform in terms of sine and cosine waveforms. (P.I.-2.2.3)* *LO 4.4: Apply fundamental concepts of product integration to compute inverse Fourier Transform. (P.I.-1.3.1)*	**07-10**	CO- 3
05.	**Complex Variables-I** ***Learning Objective/s:*** *To analyze if a given complex function is analytic or not by applying basic definitions and theorems of Complex Variables* **Contents:** Statement of D‘ Moivre‘s Theorem, Expansion of sin nθ, cos nθ in terms of sines and cosines of multiples of θ and powers of sinθ, cosθ, Complex Variables, Calculus of Complex Variables.(Limit, Continuity, Differentiability) Analytic Functions, Necessary and sufficient conditions for f(z) to be analytic (Without proof),Cauchy-Riemann equations: Cartesian and Polar coordinates ***Self-Learning Topics:*** Roots of a complex number, Conformal mapping ***Learning Outcomes :***	**05-07**	CO- 4

	A learner will be able to *LO 5.1: Interpret the real and imaginary part of complex function using the knowledge of complex variables. (P.I.-2.1.2)* *LO 5.2: Identify if given complex function is analytic or not using Cauchy Riemann Equations. (P.I.-2.1.3)* *LO 5.3: Apply mathematical techniques of calculus and algebra to solve mathematical problems of complex variables and functions. (P.I.-1.1.1)* *LO 5.4: Apply advanced techniques of analytic functions for finding derivatives of a complex function. (P.I.-1.1.3)*		
06.	**Complex Variables-II** ***Learning Objective/s:*** *The learner is expected to analyze if a given function has its harmonic conjugate and apply it for finding the Orthogonal Trajectories of a given mathematical function.* **Contents:** Milne Thompson Formula. Milne-Thomson method: Determining analytic functions when real part (u) is given and when imaginary part (v) is given. Determining analytic functions using Cauchy Riemann Equations, Harmonic function, Harmonic conjugate, Orthogonal trajectories ***Self-Learning Topics:*** *Determining analytic function when the combination of Real and Imaginary part is given, linear mapping.* ***Learning Outcomes :*** *A learner will be able to* *LO 6.1: Identify harmonic conjugates and use its knowledge to find orthogonal trajectories and confirm it using Cauchy Riemann Equations. (P.I.-2.3.2)* *LO 6.2: Apply the mathematical techniques of calculus and algebra for determining the analytic functions using Milne Thomson Formula. (P.I.-1.1.1)* *LO 6.3: Apply advanced techniques of complex variable calculus and complex variable algebra for determining the orthogonal trajectories of a mathematical function. (P.I.-1.3.1)* *LO 6.4: Identify the existence of Laplace equations and use its knowledge for Harmonic functions. (P.I.-2.1.2)*	**05-07**	CO-5
	Course Conclusion	**01**	
Total		**45**	

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, probability and statistics, Boolean algebra to solve problems.
1.1.2	Apply mathematical transforms to solve problems.
1.1.3	Apply advanced mathematical techniques such as integral and differential equations to describe/solve/construct a mathematical model of a system.
1.3.1	Apply fundamental Engineering concepts to solve Engineering problems.
2.1.1	Articulate problem statements and identify primary objectives and key constraints.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.

2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required

Course Outcomes: A learner will be able to -

1. Analyse standard Laplace and Inverse Laplace Transforms and apply it for finding solutions to Differential equations. (*LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 2.1, LO 2.2, LO 2.3, LO 2.4*)
2. Analyse periodic functions and apply the concept of Fourier series to solve Engineering Problems. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Analyse Standard Fourier transforms and apply it to solve mathematical problems. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. To analyse analytic functions by applying techniques of complex variables and complex calculus. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. To apply complex variable theory in analysing harmonic conjugates and determine orthogonal trajectories used in engineering problems. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC301.1	3	3									
ECPCC301.2	3	3									
ECPCC301.3	3	3									
ECPCC301.4	3	3									
ECPCC301.5	3	3									
Average	3	3									

Text Books :

1. Advanced Engineering Mathematics, H. K. Dass, Twenty-first Revised Edition, 2013, S.Chand and Company Ltd.

Reference Books :

1. Advanced Engineering Mathematics, Erwin Kreyszig, Eight Edition, 2010, Wiley Eastern Limited
2. Complex Variables and Applications, S. Ponnusamy and Herb Silverman, First, 2006, Birkhauser Boston
3. Higher Engineering Mathematics, Dr. B. S. Grewal, Forty Second Edition, 2017, Khanna Publication
   Laplace Transforms, Murray R. Spiegel, First Edition, 2004, Tata McGraw-Hill Publishing Company Ltd
4. Linear Algebra, Seymour Lipschutz and Marc Lipson,Forth Edition,2009, Tata McGraw-Hill Publishing Company Ltd.

Other Resources :

1. NPTEL Course: Laplace Transforms By Prof. Indrava Roy, Department of Mathematics, The Institute of Mathematical Science:-Web link https://youtube.com/playlist?list=PLyqSpQzTE6M8gnapvdLN92hs_4F75OSuH&feature=shared

2. NPTEL Course: Fourier Series by Prof. Priyanjali Pratap Singh, IIT Rorkee https://youtube.com/playlist?list=PLs7oDAL8_ouJ5w8wCPtKnK2I09MlKC6kP&feature=shared

3. NPTEL Course: Complex Analysis by Prof. P. A. S. Sree Krishna, Department of Mathematics, IIT Guwahati :-Web link https://youtu.be/Mwpz1zjPlzI?si=JU090YU2-MxJOXJD

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment - Theory (20 MARKS)**
   One MCQ test as per Gate exam pattern/ level: 5 Marks
   One Class test: 5 Marks
   One Team-pair- Solo: 5 Marks
   Regularity and attentiveness: 5 Marks

   Continuous Assessment - Tutorial (25 MARKS)
   Minimum six Tutorials: 20 Marks

   *Students must be encouraged to write at least 6 class tutorials. At least 6 Class tests will be conducted based on class tutorials on entire syllabus. Each class tests carries 20 Marks. Average will be taken of all class tests***.**

   Regularity and attentiveness: 5 Marks

2. **Mid Semester Exam (30 Marks)**
   Mid semester examination will be based on 40% to 50% of the syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC302	NETWORK THEORY	03+01*

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
ContinuousAssessment	Mid-Semester Exam (MSE)		MSE	ESE	
20+25*	30	50	1.5	2	125

Pre-requisite:

1. ESC102- Basic Electrical Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO8: Individual and teamwork

Course Objectives:

1. To impart knowledge on the fundamentals of network analysis.
2. To analyse electrical network using graph theory.
3. To acquire analytical skills to solve the network circuits using mathematical techniques .

Module	Details	Hrs.
	Course Introduction This is foundation course which deals with fundamental concepts of dependent source based electrical network theorems, graph theory based circuit analysis, frequency and time domain analysis of electrical circuit, two-port network parameters and network functions for the complex circuit analysis in terms of pole-zero based system stability, and synthesis of the networks based on the network functions. Moreover, this course is essential for the courses like Electronics Devices and Circuits, Linear Integrated Circuits, etc.	**01**
01.	**Network Theorems** ***Learning Objective:*** *Introduce students to independent and dependent sources, node and mesh techniques, superposition, Thevenin, Norton, and Maximum Power Transfer theorems.*	**06-08**
	Contents: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem. Applications: Thevenin's theorem in potential divider bias.	
	Self-Learning Topics: *Application of maximum power transfer in communication system/power system.*	

	Learning Outcomes: *A learner will be able to* *LO 1.1: Solve numerical based network theorem (P.I.1.1.1)* *LO 1.2: Apply the network theorems to find the voltage and current flowing through the network branch. (P.I.1.1.2)* *LO 1.3:.Identify the dependent and independent sources present in network. (P.I.-2.1.2)* *LO 1.4: Apply maximum power transfer theorem and find the value of RL to deliver max. power (P.I.2.1.2)*	
02.	**Graph Theory** ***Learning Objective:*** *Introduce students to objectives of graph theory, oriented and non-oriented graphs, graph terminologies, matrix representation of the graph such as incidence, reduced incidence, tieset/loop/circuit, cutset, fundamental cutset, and relationship between various matrices such as A, B, and Q.*	**05-07**
	Contents: Concept of network graphs, Tree, Link cut set, Network matrices, Node incidence matrix, Loop incidence matrix, Cutset incidence matrix, Network analysis using network incidence matrices.	
	Self-Learning Topics: *Application of graph theory in electrical network*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Convert a circuit into an oriented /non-oriented graph (PI:1.1.1).* *LO 2.2: Plot different forms (planar, non-planar, oriented, tree, co-tree) of a graph from a given circuit (PI:2.1.1).* *LO 2.3: Write/form the respective matrices from a graph obtained for a specific circuit (PI:2.1.3).* *LO 2.4: Solve KCL and KVL with the help of graph theory(P.I.-1.4.1)*	
03.	**Time and frequency domain analysis** ***Learning Objective:*** *Introduce students to time domain analysis of R-L and R-C circuits in terms of forced and natural response, initial and final values, solution of circuits represented by first and second order differential equations, frequency domain analysis of R-L-C circuits in terms of natural and forced response, effect of damping factor, and solution of circuits representing the second order differential equations.*	**07-09**
	Contents: Time domain analysis of R-L, R-C, R-L-C circuits: Forced and natural response, initial and final values, Solution using first order and second order differential equation with step signals, Frequency domain analysis of R-L, R-C, R-L-C Circuits: Forced and natural response, effect of damping factor, Analysis of electrical circuits using Laplace Transform for standard inputs, transformed network with initial conditions	
	Self-Learning Topics: *Transient behavior of an air conditioner.*	

	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply Laplace transform towrite current and voltage equations of R-L/R-C/R-L-C circuits (PI-:2.1.3)* *LO 3.2: Plot time/frequency domain response of given network. (PI:2.1.2).* *LO 3.3: Find the transfer function of step signal (P.I. 1.1.3)* *LO 3.4: Find the V and I of the RLC circuit using differential equations. (P.I.-1.1.3)* *LO 3.5: Work in a team of diverse students to learn on transient analysis in various ways (PI9.2.1)* *LO 3.6: Solve the problems related to transient analysis in a group of students (PI:8.1.1).*	
04.	**Two-port Networks** ***Learning Objectives:*** *Introduce students to open and short circuit parameters, transmission and hybrid parameters, relationship among parameters and interconnections of two-port networks T and π representation.* **Contents:** Open circuit (Z-parameters), Short circuit (Y-Parameters), Hybrid and transmission parameters (h-parameters, ABCD-Parameters), relationship among parameters and interconnections of two-port networks T and π representation,Series, parallel connections of the two-port networks, Tandem connections of two-port networks ***Self-Learning Topics:*** *Analysis of common emitter amplifier using two-port parameters.* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Identify open and short circuit parameters, transmission and hybrid parameters (PI:2.1.2).* *LO 4.2: Solve the numerical on two port network and relate various parameters (PI:1.1.2)* *LO 4.3: To perform interconnections of Two-Port Networks T & π representation (PI:2.1.3)* *LO 4.4: Define the open and short circuit parameters of the two port network (PI-2.1.3)*	**06-08**
05.	**Network Functions** ***Learning Objective/s:*** *Introduce students to one port and two port network functions, driving point and transfer function, students to poles and zeroes of network functions, necessary conditions for driving point function and transfer function, calculation of residues by graphical method, and testing for Hurwitzs polynomial and the analysis of ladder and symmetrical lattice networks.* **Contents:** Introduction, Concept of complex frequency, Immittance functions, Poles and zeros of network functions, Necessary condition for driving point Immittance functions and transfer function	**07-09**

	Self-Learning Topics: *Stability analysis through network function*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify one port and two port network functions, driving point and transfer functions (PI:2.1.3).* *LO 5.2: Apply mathematical techniques to find poles and zeros. (P.I.-1.1.1)* *LO 5.3: Identify, necessary conditions for driving point function and transfer function (P.I. 2.2.3)* *LO 5.4:Calculation of residues by graphical method(PI:1.4.1).*	
06.	**Network Synthesis** ***Learning Objective/s:*** *To formulate the state variable models to identify the Eigen values and use it to analyze the system behavior.*	**06-08**
	Contents: Positive real functions and their properties, Tests for positive real functions, Hurwitz polynomials, Driving-point synthesis of LC, RC and RL networks, Foster forms and Cauer forms.	
	Self-Learning Topics: *Signal Processing Filters, Impedance Matching Networks*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: To test the polynomial byusing fractional expansion (PI:1.1.1).* *LO 6.2: Identify Hurwitz polynomial (PI:2.1.3)* *LO 6.3: Identify the positive real functions (P.I. 2.1.2)* *LO 6.4: Compare and contrast types Foster forms P.I. (2.2.4)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques such as calculus, linear algebra, probability and statistics, Boolean algebra to solve problems.
1.1.2	Apply mathematical transforms to solve problems.
1.1.3	Apply advanced mathematical techniques such as integral and differential equations to describe/solve/construct a mathematical model of a system.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems
2.1.1	Articulate problem statements and identify primary objectives and key constraints.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the problem,

	including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solutions to select the best methodology.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills

Course Outcomes:A learner will be able to-

1. Apply techniques to analyze electric circuits having dependent sources. *(LO 1.1,LO 1.2, LO 1.3, LO 1.4)*
2. Apply graph theory concepts to analyze the electric circuits. *(LO 2.1,LO 2.2, LO 2.3, LO 2.4)*
3. Perform the transient analysis using classical and Laplace Transform methods. *(LO 3.1,LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6)*
4. Analyze the two-port network parameters and network functions-based circuits' behaviour. *(LO 4.1,LO 4.2, LO 4.3, LO 4.4, LO 5.1,LO 5.2, LO 5.3, LO 5.4)*
5. Synthesize R-L-C circuits in Cauer and Foster forms. *(LO 6.1,LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC302.1	2	3									
ECPCC302.2	3	2									
ECPCC302.3	3	3						2			
ECPCC302.4	3	3									
ECPCC302.5	2	3									
Average	3	3						2			

Text Books :

1. Basic Circuit Theory, Desoer C. A. and Kuh E. S., McGraw Hill International Book Company.
2. Network Analysis, Valkenberg V, 3rd Ed., 2007 International Edition, Prentice Hall
3. Network Analysis and Synthesis, Franklin F Kuo, 2 nded, 1966, Wiley Toppan
4. Circuit Theory, A. Chakrabarti, 6th Edition, Dhanpat Rai &Co.Delhi
5. Network Analysis and Synthesis, K. M. Soni, S. K. Kataria and Sons
6. Network Theory Analysis and Synthesis, Ravish Singh, Mc Graw Hill

Reference Books :

1. Networks and Systems, D. Roy Choudhury, 1998, New Age International
2. Circuits and Networks, Sudhakar, Shyammohan, S. Palli, Tata McGraw-Hill education

Other Resources :

1. Course: Network Analysis byProf.Tapan Kumar Bhatttacharya, IIT Kharagpur; Weblink- https://archive.nptel.ac.in/courses/108/105/108105159/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment -Theory-(20 Marks)

Suggested breakup of distribution

a) One MCQ test as per GATE exam pattern / level: 05 Marks

b) One Class test:05 Marks

c) Open book test/ Open notes test: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC303	ELECTRONIC DEVICES AND CIRCUITS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. BSC205- Engineering Physics-II
2. ESC203- Basic Electronics Engineering

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO8: Individual and teamwork
5. PO9: Communication

Course Objectives :

1. To impart the knowledge to analyse and design various amplifiers using bipolar and unipolar devices.
2. To introduce various types of power amplifier circuits.
3. To impart the knowledge to analyse MOSFET based differential amplifier.
4. To introduce advanced FETs like HEMT and MESFETS.

Module	Details	Hrs
	Course Introduction Electronic devices and circuits play an indispensable role in both industry and daily life. In Industry, they enable automation, control systems, and data processing, enhancing efficiency and precision across manufacturing processes. Electronics also underpin vital communication networks, including the internet and mobile networks, connecting people globally. EDC is crucial for courses like Communication System, where it forms the basis for signal processing and modulation techniques. Moreover, in courses such as Microelectronics, EDC concepts are essential for designing and analysing integrated circuits and semiconductor devices.	**01**

01.	**BJT Amplifiers**	**05-07**
	Learning Objective/s:	
	To analyze and design BJT based amplifiers using concepts of low/high frequency modelling.	
	Contents:	
	Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier, tuned amplifier, applications of each type of amplifier. Small signal analysis, low frequency models (Ebers-Moll model and hybrid-pi model), estimation of voltage gain, current gain, input resistance and output resistance. Design procedure for particular specifications, frequency analysis of multistage amplifiers. High frequency modelling and analysis of CE amplifiers.	
	Self-Learning Topics:	
	High frequency applications of BJT amplifiers. Read datasheet of high Frequency transistor BF 547.	
	Learning Outcomes :	
	A learner will be able to *LO 1.1: Identify engineering variables, and parameters of the BJT amplifier circuit to draw the small signal model. (P.I 1.2.1)* *LO 1.2: Identify the mathematical electronics engineering knowledge that applies to analyzing amplifier circuits.(P.I 2.1.3)* *LO 1.3: Identify existing solution methods for solving the problem, and form justified approximations for circuit parameters. (P.I 2.2.3)* *LO 1.4: Identify suitable criteria and relevant data from datasheets to arrive at an amplifier design solution . (P.I 3.2.2, P.I 3.3.3)*	
02.	**Field Effect Devices: JFET**	**09-10**
	Learning Objective/s:	
	To analyze and design JFET based amplifiers using concepts of low/high frequency modelling.	
	Contents:	
	Construction, Principle of Operation, device characteristics and applications. Biasing schemes for FET amplifiers, bias stability, various configurations (such as CS, CG, CD) and their features, small signal analysis, low frequency models, estimation of voltage gain, input resistance, output resistance etc., design procedure for CS configuration with particular specifications, frequency analysis of multistage amplifiers.	
	Self-Learning Topics:	
	High frequency analysis of JFET CS amplifier	

	Learning Outcomes :	
	A learner will be able to *LO 2.1: Apply concepts of electronics and communication engineering to solve engineering problem on JFET amplifier. (P.I.-1.4.1)* *LO 2.2: Identify the mathematical electronics engineering knowledge that applies to analyzing amplifier circuits.(P.I 2.1.3)* *LO 2.3: Identify suitable criteria and relevant data from datasheets to arrive at an amplifier design solution . (P.I 3.2.2, P.I 3.3.3)* *LO 2.4: Demonstrate effective problem-solving skills during the design based activity learning and present the written results as a team. (P.I 3.3.3, P.I 8.3.1, P.I 9.1.1, P.I 9.1.2)*	
03.	**Field Effect Devices: MOSFET**	**09-10**
	Learning Objective/s:	
	To analyze and design MOSFET based amplifiers using concepts of low/high frequency modelling.	
	Contents:	
	Construction, Principle of Operation, device characteristics and applications. Small Signal Equivalent circuits of MOSFET. Introduction, Analysis and design of CS Amplifier, MOSFET based switch. High and low frequency analysis of CS (MOSFET) amplifier.	
	Self-Learning Topics:	
	Study datasheet of Infineon's IRFZ44N MOSFET.	
	Learning Outcomes :	
	A learner will be able to *LO 3.1: Apply concepts of electronics and communication engineering to solve engineering problem on JFET amplifier. (P.I.-1.4.1)* *LO 3.2: Identify the mathematical electronics engineering knowledge that applies to analyzing amplifier circuits.(P.I 2.1.3)* *LO 3.3: Identify suitable criteria and relevant data from datasheets to arrive at an amplifier design solution . (P.I 3.2.2, P.I 3.3.3)* *LO 3.4: Demonstrate effective problem-solving skills during the design based activity and present the written results as a team. (P.I 3.3.3, P.I 8.3.1, P.I 9.1.1, P.I 9.1.2)*	
04.	**Large Signal Amplifiers**	**09-10**
	Learning Objective/s:	
	Classify and Analyze types of power amplifiers	
	Contents:	
	Difference between small signal & large signal amplifiers, Classification and applications of Power amplifier. Working and analysis of Class A power amplifier (Series fed and transformer coupled), Class B power amplifier, Class AB with diode biasing. Thermal considerations and heat sinks.	
	Self-Learning Topics:	

	Comprehending the implementation of audio power amplifier used in headphones drivers/cellphones/Televisions.	
	Learning Outcomes :	
	A learner will be able to *LO 4.1: Apply fundamental engineering concepts to solve problem on power amplifiers. (P.I 1.3.1)* *LO 4.2: Apply concepts of Electronics and communication engineering and allied disciplines to solve problem power amplifiers. (P.I 1.4.1)* *LO 4.3: Identify engineering systems, variables, and parameters to compare power amplifiers. (P.I 2.1.2)* *LO 4.4: Identify the engineering knowledge that applies to given problems of incorrect biasing and heat dissipation. (P.I 2.1.3)*	
05.	**Differential Amplifiers**	**06-07**
	Learning Objective/s:	
	Introduce the circuits of differential amplifiers and analyze the circuits.	
	Contents:	
	Introduction to basic Differential amplifier, Need of Differential amplifier, parameters of diff. amplifiers, AC and DC analysis of MOSFET based Differential amplifier.	
	Self-Learning Topics:	
	Read datasheet of INA592 from Texas Instruments.	
	Learning Outcomes :	
	A learner will be able to *LO 5.1: Apply fundamental engineering concepts to solve problem on power amplifiers. (P.I 1.3.1)* *LO 5.2: Apply concepts of Electronics and communication engineering and allied disciplines to solve problems on differential amplifier. (P.I 1.4.1)* *LO 5.3: Identify engineering systems, variables, and parameters to solve the problems on power amplifier analysis. (P.I 2.1.2)* *LO 5.4: Identify the mathematical and engineering knowledge that applies to given problem on analysis of differential amplifier. (P.I 2.1.3)*	
06.	**Advanced FETs**	**01-03**
	Learning Objective/s:	
	To comprehend the principle and working of HEMT, MESFETS.	
	Contents:	
	Device structure, principle of operation and V-I characteristics of MODFET (i.e. HEMT), MESFET and HBT, comparison of advanced FETs with MOSFETs.	
	Self-Learning Topics:	
	Read about "MOSFETs based Memory Registers"	
	Learning Outcomes :	
	A learner will be able to	

	LO 6.1: Apply fundamental engineering concepts to summarize the principle and working of HEMT, MESFETS. (P.I 1.4.1) *LO 6.2: Apply concepts of electronics and communication engineering to analyze V-I characteristics of Advanced FETs. (P.I 1.3.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
3.2.2	Identify suitable criteria for evaluation of alternate design solutions
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and/or non-technical information.
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.

Course Outcomes: A learner will be able to -

1. Analyse BJT and FET based amplifiers. *(LO 1.1,LO 1.2, LO 1.3, LO 2.1, LO 2.2, LO 3.1, LO 3.2)*
2. Design BJT and FET based amplifiers. *(LO 1.4, LO 2.3, LO 2.4, LO 3.3, LO 3.4)*
3. Compare different types of power amplifiers. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Analyse working and performance parameters of Differential Amplifier. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Comprehend principle of working of MESFETS, HEMT and HBT. *(LO 6.1, LO 6.2)*

CO-PO Mapping Table with Correlation Level

CO ID	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
ECPCC303.1	3	3									
ECPCC303.2			3					2	3		
ECPCC303.3	3	3									
ECPCC303.4	3	3									
ECPCC303.5	3										
Average	3	3	3					2	3		

Text Books :

1. "Electronic Devices and Circuit Theory", R. Boylestad and L. Nashelsky, 9th Edition, 2009, PHI.
2. "Electronic Circuit Analysis and Design", D. A. Neamen, 2nd Edition, 2012, Tata McGraw Hill.
3. "Electronic Devices and Circuits", J. Millman, C. Chalkias, and S. Millman, 3rd Edition, 2018, Tata McGraw Hill.
4. "Electronic Devices and Circuits", N. Salivahanan and N. Suresh Kumar, 3rd Edition, 2017, Tata McGraw Hill.
5. "Microelectronic Circuits", A. S. Sedra and K. C. Smith, 5th Edition, 2004, Oxford University Press.

Reference Books :

1. "Microelectronics Circuits Analysis and Design", Muhammad H. Rashid, 2nd Edition, Cengage Learning, 2012.
2. "Electronic Devices and Circuits", Allen Mottershed, 2nd Edition, 1979, PHI.

Other Resources :

1. NPTEL Course: Analog Electronic Circuits By Prof. Pradip Mandal, Department of Electronics and Electrical Engineering, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/108105158
2. NPTEL Course: Analog Circuits By Prof. A.N. Chandorkar, Department of Electrical Engineering, IIT Bombay :-Web link- https://nptel.ac.in/courses/117101106

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

Numerical Assignments (min 20 problems) -05 marks

One Class test based on above numerical assignments-05 marks

Think-pair-share worksheets-05 Marks

Regularity and active participation- 05 marks

2. Mid Sem Exam (30 Marks)

Mid semester examination will be based on 40% to 50% of syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20 to 30% weightage, and the syllabus covered from MSE to ESE carrying 70 to 80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC304	DIGITAL CIRCUIT DESIGN	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ESC102: Basics of Electrical Engineering
2. ESC203: Basic Electronics Engineering

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering tool usage

Course Objectives :

1. To learn the signed numbers representation and its arithmetic operations.
2. To construct the digital logic functions used for switching circuits.
3. To implement combinational and sequential circuits using MSI
4. To develop hardware construct of combinational and sequential circuits using Hardware descriptive language.

Module	Details	Hrs
	Course Introduction Digital circuit design is the foundation course in digital design and main stream technology of today's digital system. The digital circuits are widely used in industrial machinery, computers, microprocessors, household appliances, medical equipment, internet and e-commerce. In fact, digital techniques have been increasing day by day in all applications. However, digital design engineer rely heavily on computer based aids i.e., hardware description language (HDL) in integrated circuits designs. The digital circuit design is also the prerequisite for microcontrollers, embedded system and VLSI courses.	**01**
01.	**Signed Binary numbers and Codes** ***Learning Objective/s:*** *To formulate binary arithmetic operations used in computer environment by applying floating point standard, sign magnitude representation and binary codes on decimal number.*	**4 - 6**
	Contents:	

	Digital system, Signed Binary numbers and its signed magnitude, 1's and 2's complement representation, Addition of signed numbers, Booth's multiplier algorithm, Floating point representation of binary numbers, Parity and 7-bit Hamming code	
	Self-Learning Topics: *Alphanumeric Codes* ***Learning Outcomes :*** *A learner will be able to* *LO1.1: Represent the decimal numbers in binary by applying sign magnitude representation techniques. (P.I.-1.1.1)* *LO1.2: Apply floating point standard to represent decimal number in binary to solve the engineering problem in computer environment. (P.I.-1.4.1)* *LO1.3: Perform the arithmetic operations on signed binary numbers. (P.I.-2.4.1)* *LO1.4: Identify the error in received binary information using 7-bit hamming code. (P.I.-2.4.3)*	
02.	**Logic Families and canonical and standard form** ***Learning Objective/s:*** *To design the switching circuit of Electrical appliances by applying basic logic gates with minimal gate count and summarize the characteristics of CMOS of TTL logic families of these logic gates ICs.*	**6 - 8**
	Contents: CMOS and TTL Logic families, Digital IC characteristics, Meta stability, skew, Realize switching circuits using gates, De Morgan and Duality Theorem, SOP, POS representation and canonical conversion, K-map up to 4 variables, Don't care terms	
	Self-Learning Topics: *Qunie McCluskey*	
	Learning Outcomes : *A learner will be able to* *LO2.1: Apply the Boolean algebra/theorem to minimize standard canonical equations. (P.I.-1.1.1)* *LO2.2: Differentiate CMOS and TTL Logic Family. (P.I.-1.2.1)* *LO2.3: Design switching circuits using basic gates for given functions used in digital system (P.I.-3.1.6)* *LO2.4: Build the logic design to operate electrical appliances. (P.I.-3.2.2)*	
03.	**Combinational System design and MSI Circuits** ***Learning Objective/s:*** *To design combinational logic circuit i.e., adder, subtraction, code converter, used in arithmetic logic unit of the microprocessor/ controller using basic logic gates as well as MSI Chips.*	**6 -8**
	Contents:	

	Half adder , full adder , half subtractor, full subtractor, 4-bit addition and subtraction using IC 7483, Design of binary multiplier and 4-bit magnitude comparator, MSI circuits: mux, demux, decoder, encoder	
	Self-Learning Topics: *ALU 74181* ***Learning Outcomes :*** *A learner will be able to* *LO3.1: Design full adder/subtractor using two half adder/subtractor. (P.I.-3.1.6)* *LO3.2: Identify the MSI chips to implement the 4bit binary adder. (P.I.-3.3.3)* *LO3.3: Identify fast binary multiplier algorithm and apply it to design the 4-bit multiplier. (P.I.-2.2.3)* *LO3.4: Identify given combinational design and write its truth table. (P.I.-2.1.1)*	
04.	**Sequential logic** ***Learning Objective/s:*** *To analyze the build blocks of clocked sequential circuits i.e., flip flops and design the sequential circuits using MSI chips.*	**7 - 9**
	Contents: Introduction to 1-bit memory cell, Sequential circuits: SR, JK, D and T, MS JK Flip-flop , triggering methods, Excitation tables and conversion of flip-flop, Counter, modulus of counter, 4 bit asynchronous- counter using flip flops and MSI chips 7490, 7493, Shift registers using array of flip flops and MSI chip 7495	
	Self-Learning Topics: *Applications of flip flops: Bounce Elimination switches, Latch, memory* ***Learning Outcomes :*** *A learner will be able to* *LO4.1: Perform the flip-flop conversions using excitation table. (P.I.-2.2.3)* *LO4.2: Tabulate the truth table of given flip-flop and state it's on applied inputs. (P.I.-2.4.4)* *LO4.3: Design mod-n counter using flips flops. (P.I.-3.1.6)* *LO4.4: Identify the MSI chips to implement mod-n counter. (P.I.-3.3.3)*	
05.	**Verilog Programming** ***Learning Objective/s:*** *To design the combinational and sequential circuits using hardware descriptive language used computer aided design tool.*	**7 - 9**
	Contents: Merit and demerits of HDL, Types of HDL: VHDL, Verilog and system Verilog, Verilog Constructs-Concurrent and Sequential,	

	Develop a Verilog code for, adder/subtractor, decoder, Programmable logic devices: CPLD and FPGA	
	Self-Learning Topics: *VHDL and system Verilog constructs, Verilog constructs of basic gates.* ***Learning Outcomes :*** *A learner will be able to* *LO5.1: Identify the strength and limitations of HDL. (P.I.-5.3.2)* *LO5.2: Identify the Verilog constructs to design combinational as well as sequential circuits. (P.I.-5.1.1)* *LO5.3: Design and optimize combinational circuits such as adder, subtractor and decoder using Verilog. (P.I.-3.3.1)* *LO5.4: Elicit the architectural features of PLDs. (P.I.-3.1.2)*	
06.	**FSM: Moore and Mealy machines** ***Learning Objective/s:*** *To design and analyze finite state machines of clocked sequential circuits widely used in digital designs and programmable logics.* **Contents:** Introduction to Moore and Mealy machines, Counters using Moore and Mealy machines, Binary sequence detector and it application, Verilog codes of synchronous counter and sequence detector ***Self-Learning Topics:*** *State reduction techniques* ***Learning Outcomes :*** *A learner will be able to* 1. *LO6.1: Differentiate synchronous and asynchronous counters and Mealy and Moore machines. (P.I.-2.4.4)* 2. *LO6.2: Design a synchronous counter using Moore Machines. (P.I.-3.1.6)* 3. *LO6.3: Design sequence detector using Mealy as well as Moore machines. (P.I.-3.1.6)* 4. *LO6.4: Identify the given state machine and analyse its states. (P.I.-2.1.1)* 5. *LO6.5: Design and optimize sequential circuits such as flip flops, counters, shift register and sequence detector using Verilog constructs. (P.I.-3.3.1)*	**7 - 9**
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, probability and statistics, Boolean algebra to solve problems
1.2.1	Apply laws of natural science to an engineering problem
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.1	Articulate problem statements and identify primary objectives and key constraints.

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions

2.4.1 Apply engineering mathematics and computations to solve mathematical models

2.4.3 Identify sources of error in the solution process, and limitations of the solution.

2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

3.1.2 Elicit and document, engineering requirements from stakeholders

3.1.6 Determine design objectives, functional requirements and arrive at specifications

3.2.2 Identify suitable criteria for evaluation of alternate design solutions

3.3.1 Apply formal decision-making tools to select optimal engineering design solutions for further development

3.3.3 Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.

5.1.1 Identify modern hardware and software engineering tools, techniques and resources for engineering activities.

5.3.2 Recognize the limitations of the capabilities of the tools used/created.

Course Outcomes:

A learner will be able to -

1. Perform arithmetic operations on signed binary numbers and illustrate the knowledge of binary codes used in digital circuits. *(LO 1.1,LO 1.2, LO 1.3, LO 1.4)*
2. Illustrate the knowledge of digital logic families, characteristics of Digital ICs, Boolean algebra, digital switching circuits used in digital designs. *(LO 2.1,LO 2.2, LO 2.3, LO 2.4)*
3. Designs combinational logic circuits and realizations using MSI circuits. *(LO 3.1,LO 3.2, LO 3.3, LO 3.4)*
4. Illustrate the knowledge of flip –flops to construct counters and shift registers using MSI. *(LO 4.1,LO 4.2, LO 4.3, LO 4.4)*
5. Design combinational and sequential circuits using Verilog. *(LO 5.1,LO 5.2, LO 5.3, LO 5.4)*
6. Design sequence detector using Moore and Mealy machines. . *(LO 6.1,LO 6.2, LO 6.3, LO 6.4,LO 6.5)*

CO-PO Mapping Table with Correlation Level

RCO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC304.1	3	3									
ECPCC304.2	3		3								
ECPCC304.3		3	3								
ECPCC304.4		3	3								
ECPCC304.5			3		3						
ECPCC304.6		3	3								
Average	3	3	3		3						

Text Books :

1. Modern Digital Electronics, R. P. Jain, , Fourth Edition, 2009, Tata McGraw Hill Education
2. Digital Design With an Introduction to the Verilog HDL, VHDL, and System Verilog, Morris Mano Michael D. Ciletti, Sixth Edition, Pearson

Reference Books :

1. Fundamentals of Digital Circuits, Anand Kumar, Fourth Edition, 2018, PHI learning

2. Digital Fundamentals, Thomas L. Floyd, Eleventh Global Edition, 2015, Pearson Prentice Hall
3. Digital Electronics Principles and Applications, Mandal, First Edition, 2010, McGraw Hill Education
4. A Verilog HDL Primer, J. Bhasker, Third Edition, 1997, Star Galaxy Press

Other Resources :

1. https://www.vlab.co.in/broad-area-electronics-and-communications
2. "Using Practical Examples in Teaching Digital Logic Design", Dr. Joseph P Hoffbeck, University of Portland

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

Numerical Assignment/s (min 20 problems): 05 marks
Class test based on above numerical assignment:05 marks each
Article reading & summarization/poster creation: 05 Marks
Regularity and active participation:05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination(MSE) carrying 20 to 30 % weightage, and the syllabus covered from MSE to ESE carrying 70 to 80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC301	ELECTRONIC DEVICES AND CIRCUIT LABORATORY	02

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. BSC205- Engineering Physics-II
2. ESC203- Basic Electronics Engineering

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/ Development of Solutions.
4. PO4: Conduct Investigations of Complex Problems.
5. PO5: Engineering Tool Usage
6. PO6: The Engineer and The World
7. PO8: Individual and Team Work
8. PO9: Communication
9. PO11: Life-long learning

Course Objectives:

1. To Design BJT/ FET based Amplifiers.
2. To measure the resonant frequency, bandwidth, and quality factor of an LC resonant circuit.
3. To design and implement a relay driver circuit using a Darlington pair configuration.
4. To design and develop a switches using BJT/ FETs.
5. To identify and rectify faults in each transistorized circuit.
6. To apply the knowledge and skills acquired throughout the course to complete a comprehensive project.

Module	Details	Hrs.
	Course Introduction The Electronics Devices and Circuits lab will provide hands-on experience to students in designing, building and analyzing electronic circuits. Through this lab, students will gain practical insights into the behavior and characteristics of electronic components such as diodes, transistors. They will also gain experience in using instruments for generation of input and measurement of output. They will learn essential skills for circuit prototyping, troubleshooting and measurement techniques, which are fundamental for their understanding and application in real-world electronic systems. Electronics devices and circuits find widespread application in industries for automation and control systems, powering machinery, and ensuring efficient production processes. In real life, they are integral to modern	**01**

	communication systems, including smartphones, Wi-Fi routers, and satellite communication. Moreover, electronics circuits are crucial components in transportation systems, facilitating navigation, vehicle control, and safety features in automobiles, trains and aircraft. The most basic and essential part of any electronic manufacturing is PCB design and development. PCB manufacturing is covered as a part of this course.	
01.	***Learning Objective:*** *To design and analyze the performance of CE Amplifier.*	**02**
	Contents: 1. Design & Implement BJT CE Amplifier circuit for amplifying signal within audio frequency range. 2. Design & Implement BJT CE Amplifier circuit for amplifying signal within low frequency range. 3. Design & Implement BJT CE Amplifier circuit for amplifying signal within radio frequency range.	
	Self-Learning Topics: *Simulate a CE Amplifier.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Determine objectives and requirements to design CE Amplifier. (P.I. - 3.1.6)* *LO 1.2: Identify relevant data from the given resources and arrive at an optimal design solution of CE amplifier for particular specification. (P.I. -3.3.3)* *LO 1.3: Use appropriate procedure and components to implement amplifier on bread board (P.I.- 4.3.1)* *LO 1.4: Produce and validate the result theoretically and practically.(P.I.-2.4.2)* *LO 1.5: Extracts desired understanding and conclusions through analysis (P.I.-2.4.4)* *LO 1.6: Read, understand and use transistor specifications from datasheet. (P.I. - 9.1.1)* *LO 1.7: Create clear, well-constructed and well supported written document including design, result and conclusion. (P.I. -9.1.2)*	
02.		**02**
	Learning Objective: *Design and analyze the performance LC tuned amplifier for a particular band of frequency.*	
	Contents: 1. Design & Implement of Parallel LC Tuned Amplifier for FM Band. 2. Design & Implement of Parallel LC Tuned Amplifier for AM Band.	
	Self-Learning Topics: *Find out in which areas of communication LC Tuned Amplifiers are used.*	
	Learning Outcomes: *A learner will be able to*	

	LO 2.1: Determine objectives and requirements to design LC tuned Amplifier. (P.I. - 3.1.6) *LO 2.2: Identify relevant data from the given resources and arrive at an optimal design solution of parallel LC amplifier for particular specifications. (P.I. -3.3.3)* *LO 2.3: Use appropriate procedure and components to implement tuned amplifier on bread board (P.I.- 4.3.1)* *LO 2.4: Produce and validate the result theoretically and practically. (P.I. -2.4.2)* *LO 2.5: Extracts desired understanding and conclusions through analysis. (P.I.- 2.4.4)* *LO 2.6: Read, understand and use transistor specifications from datasheet. (P.I. -9.1.1)* *LO 2.7: Create clear, well-constructed and well supported written document including design, result and conclusion. (P.I.- 9.1.2)*	
03.		**02**
	Learning Objective: *Conduct Investigations and implement circuit for Smart Home using sensors and actuators.*	
	Contents: Implement a circuit for Smart Home. Examples: 1. Light sensing and Control: Use a light-dependent resistor (LDR) as a sensor to detect ambient light levels. Connect the LDR to a transistor-based switch circuit to control the lighting system, such as turning lights on/off automatically based on the detected light level. 2. Smoke/Fire Detection: Integrate smoke or fire sensors into the circuit to detect the presence of smoke or fire. When smoke or fire is detected, the sensor triggers a transistor-based alarm circuit, such as a siren or a flashing light, to alert occupants and prompt appropriate action. 3. Temperature Sensing and control: Utilize a temperature sensor, such as a thermistor or a temperature-dependent resistor (RTD), to monitor room temperature. Connect the temperature sensor to a transistor-based circuit that controls a fan or heating system based on the temperature readings.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Establish a relationship between measured data and physical phenomenon. (P.I.-4.1.4)* *LO 3.2: Use appropriate tools and techniques to conduct experiment and collect data. (P.I. - 4.3.1)*	
04.		**02**
	Learning Objectives: *To analyse the principle and working of Darlington pair configuration and establish relation between output of amplifier and speed of motor*	
	Contents: 1. Speed control of motors using Darlington pair TIP120 2. Darlington pair as an Amplifier. 3. Touch sensor using Darlington pair	

	Self-Learning Topics: *Comprehend the principles behind relay operations and specify the types.*	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Use appropriate procedure and components to implement circuits based on Darlington pair on bread board (P.I.- 4.3.1)* *LO 4.2: Establish a relationship between measured data and physical phenomenon. (P.I.-4.1.4)* *LO 4.3: Extracts desired understanding and conclusions through analysis. (P.I.- 2.4.4)*	
05.	***Learning Objective/s:*** *Design and analysis of performance of FET based amplifier circuits for electronic applications.*	**02**
	Contents: 1. Design and Implementation of a MOSFET CS amplifier for LNA. 2. Analyse the frequency response of a MOSFET CS amplifier and determine its bandwidth and gain limitations.	
	Self-Learning Topics: *Datasheets of Mosfets*	
	Learning Outcomes :	
	A learner will be able to *LO 5.1: Recognize the need to design MOSFET CS amplifier. (P.I. -3.1.1)* *LO 5.2: Determine objectives and requirements to design MOSFET CS Amplifier (P.I. -3.1.6)* *LO 5.3: Produce and validate the result theoretically and practically. (P.I. -2.4.2)* *LO 5.4: Extracts desired understanding and conclusions through analysis. (P.I.- 2.4.4)* *LO 5.5: Read, understand and use transistor specifications from datasheet. (P.I. –9.1.1)* *LO 5.6: Create clear, well-constructed and well supported written document including design, result and conclusion. (P.I. 9.1.2)*	
06.		**02**
	Learning Objective/s: *Design and implement MOSFET based circuits.*	
	Contents: 1. Design & implement constant current source using MOSFET for current stabilizer circuits. 2. To study the switching characteristics of a MOSFET and understand its behavior in different operating regions.	
	Self-Learning Topics: *Various techniques for creating constant current sources using transistors, operational amplifiers, and integrated circuits.*	
	Learning Outcomes:	

	A learner will be able to *LO 6.1: Recognize the requirements of constant current source to design MOSFET current stabilizer circuits (P.I. -3.1.1)* *LO 6.2: Determine objectives and requirements to design current stabilizer circuit. (P.I. -3.1.6)* *LO 6.3: Produce and validate the result theoretically and practically.(P.I.-2.4.2)* *LO 6.4: Extracts desired understanding and conclusions through analysis. (P.I. -2.4.4)* *LO 6.5: Read, understand and use transistor specifications from datasheet. (P.I. -9.1.1)* *LO 6.6 : Create clear, well-constructed and well supported written document including design, result and conclusion. (P.I.- 9.1.2)*	
07.	***Learning Objective/s:*** *Design and implement MOSFET-based switching circuits for specific requirements.*	**04**
	Contents: 1. Simulate a BJT and MOSFET based switch. 2. Develop a MOSFET switch for turning on a staircase lamp.	
	Self-Learning Topics: *Learn about the differences in behavior, characteristics and applications of BJTs and MOSFETs.*	
	A learner will be able to *LO 7.1: Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications. (P.I -3.3.3)* *LO 7.2: Generate information through appropriate tests to improve or revise the design. (P.I 3.4.2)* *LO 7.3: Attain proficiency in circuit simulation techniques. (P.I.-5.2.2)* *LO 7.4: Utilize software tools to model, analyze, and troubleshoot electronic circuits effectively. (P.I.-5.1.2)*	
8	***Learning Objective/s:*** *Identify errors in the given circuit, rectify it and produce accurate results.*	**02**
	Contents: Troubleshoot the given transistorized circuit assigned by lab instructor and rectify the errors.	
	Self-Learning Topics: *Read signal tracing techniques.*	
	LO 8.1: Identify sources of error in the solution process, and limitations of the solution. (P.I.- 2.4.3) *LO 8.2: Produce and validate results through skillful use of contemporary engineering techniques. (P.I.- 2.4.2)*	
9	***Learning Objective/s:*** *Design a PCB and analyses it for defects.*	**04**
	Contents: Introduction to PCB fabrication PCB design concepts, effects of ill-designed PCB	
	Self-Learning Topics: *Read types of PCB*	
	LO 9.1: Identify engineering systems, variables, and parameters to start the process of PCB designing. (P.I. -2.1.2) *LO 9.2: Identify the mathematical, engineering and other relevant knowledge*	

	that applies to PCB designing. (P.I. - 2.1.3) *LO 9.3: Determine design objectives, functional requirements and arrive at specifications in-order to develop a single sided PCB. (P.I.- 3.1.6)* *LO 9.4: Refine a conceptual design into a detailed design within the existing constraints (of the resources). (P.I.- 3.4.1)*	
10	***Learning Objective/s:*** *Develop a need based project in groups, carry investigations on it.*	**07**
	Contents: Course Project on a PCB.	
	Self-Learning Topics:	
	LO 10.1: Identify suitable criteria for evaluation of alternate design solutions while selecting the components or tools for designing. (P.I. -3.2.3) *LO 10.2: Apply formal decision-making tools like eagle, PCB-maker to select optimal engineering design solutions for further development. (P.I. - 3.3.1)* *LO 10.3: Define a problem, its scope, and importance for purposes of investigation while deciding the course project's scope. (P.I.- 4.1.1)* *LO 10.4: Use appropriate procedures, tools, and techniques to conduct investigations and collect data during the course project. (P.I. - 4.3.1)* *LO 10.5: Identify and evaluate the potential risks to human health and environment due to PCB manufacturing process. (P.I. -6.1.3)* *LO 10.6: Demonstrate effective communication, problem-solving, conflict resolution and leadership skills during the course project. (P.I.- 8.2.1)* *LO 10.7: Present results as a team, with smooth integration of contributions from all individual efforts. (P.I.- 8.3.1)* *LO 10.8: Develop the ability to identify and address challenges encountered during the project, applying troubleshooting and critical thinking skills. (P.I.- 11.1.3)* *LO 10.9: Source and comprehend technical literature and other credible sources of information (P.I.- 11.3.1)*	
	Minimum one experiment from each module is mandatory.	
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.3	Identify sources of error in the solution process and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.1	Recognize that need analysis is key to good problem definition.

3.1.6 Determine design objectives, functional requirements and arrive at specifications
3.2.3 Identify suitable criteria for evaluation of alternate design solutions
3.3.1 Apply formal decision-making tools to select optimal engineering design solutions for further development
3.3.3 Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
3.4.1 Refine a conceptual design into a detailed design within the existing constraints (of the resources)
3.4.2 Generate information through appropriate tests to improve or revise the design
5.1.2 Use/adapt/modify/create tools and techniques to solve engineering problems
5.2.2 Demonstrate proficiency in using discipline-specific tools.
5.3.2 Recognize the limitations of the capabilities of the tools used/created.
6.1.3 Identify and evaluate the potential risks to human health and environment due to an engineering product design or modelling technique
8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1 Read, understand and interpret technical and/or non-technical information.
9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
11.1.3 Develop ability to learn independently through methods distinct from instructor provided materials.
11.3.1 Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Design and implement BJT/FET amplifier circuits. *(LO 1.1-1.7, LO 2.1-2.7, LO 5.1-5.6)*
2. Implement and test BJT/FET based circuits for specific applications. *(LO3.1-3.2, LO 4.1-4.3, LO 6.1-6.6, LO 7.1-7.4)*
3. Troubleshoot a given circuit and rectify faults. *(LO 8.1-8.2)*
4. Comprehend the process of PCB manufacturing. *(LO 9.1-9.4)*
5. Apply the knowledge and skills acquired throughout the course to complete a comprehensive project on PCB. *(LO 10.1-10.9)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC301.1		3	3	2					3		
ECPCC301.2		3	3	3	3				3		
ECPCC301.3		3									
ECPCC301.4		3	3								
ECPCC301.5			3	3		2		3			3
Average		3	3	3	3	2		3	3		3

Text Books :

1 Electronic Devices and Circuits, J. Millman, Christos CHalkias and Satyabratatajit, 3rd edition, October 2017, Tata McGraw Hill.

2 Electronic Devices and Circuit Theory, R. Boylestad and L. Nashelsky, 9th edition,2009, PHI.
3 Electronic Circuit Analysis and Design, D. A. Neamen, 2nd edition,2012, Tata McGraw Hill.
4 Electronic Devices and Circuits, Salivahanan, N. Suresh Kumar, 3rd edition, June-2012, Tata McGraw Hill.
5 Microelectronic Circuits, A. S. Sedra and K. C. Smith, 5th edition, 2004, Oxford University Press.
6 Electronic Devices and Circuits, Dr. R. S. Sedha and B. L. Theraja, 2011, S. Chand Publication.

Reference Books :

1 Microelectronics Circuits Analysis and Design, Muhammad H. Rashid, 2nd edition, 2012, Cengage Learning.
2 Electronic Devices and Circuits, Allen Mottershed, 2nd edition, 1979, PHI.
3 Practical Electronics for Inventors, P. Scherz and S. Monk, McGraw-Hill Education, ISBN: 978-0071771337.
4 Troubleshooting Electronic Circuits: A Guide to Learning Analog Electronics, R. Quan, McGraw-Hill Education, ISBN: 978-0071830454.
5 Electronic troubleshooting, Daniel R. Tomal, 4th edition, 2014, McGraw Hill Education.

Other Resources:

1. Matlab support for amplifiers: https://www.mathworks.com/help/sps/amplifiers.html
2. Tinkercad, a free web app for electronics: https://www.tinkercad.com/things/hbUSKrp8XXl-resources
3. The Proteus Design Suit: https://www.labcenter.com/

A. CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

a. Experiment execution: 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observations, interpret results/conclusion and prepare a brief report as per requirement.

b. Course project: 10 Marks.

Based upon the learnings from the experiments, students will be assigned a course project. They are expected to do the design, verification, simulation (if required) and implementation on PCB followed by testing for desired output.

c. Regularity and active participation: 5 marks.

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/circuit knowledge
- Accurate output
- Plotting of graphs
- Oral

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw the circuit diagram for the same. The circuit diagram is checked by the examiners (Internal and External) and evaluated out of 05 Marks.

  Then the student will be allowed to start with the implementation of the circuit.
- Students will be allocated 1 hour to complete the connections and observe the output. The output is then checked by both the examiners for its correctness. The weightage of the circuit implementation is 10 Marks.
- Students will then be appearing for Oral Examination in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LC	ECLBC302	DIGITAL CIRCUIT DESIGN LABORATORY	02

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
25	25	50

Pre-requisite :

1. ESC102: Basics of Electrical Engineering
2. ESC203: Basic Electronics Engineering

Program Outcomes addressed :

1. PO 3: Design/Development of Solutions
2. PO 4: Conduct investigations of complex problems
3. PO 5: Engineering tool usage
4. PO 8: Individual and Collaborative teamwork
5. PO 9: Communication

Course Objectives :

1. To provide the learner the comprehension of logic gates and enable them to relate the logic to real world applications.
2. To handle the electronics devices i.e., power supply, multi-meter, function generator, Cathode ray oscilloscope to test and verify digital circuits.
3. To handle computer based aids (Tools) to develop, test and debug hardware descriptive language code

Module	Detailed Contents	Hrs
	Course Introduction The control circuits in industrial machinery are based on digital logics. This course is developing the logic for digital controller and its prototyping. The digital design engineers are designing the circuits using computer based aids i.e., hardware description language (HDL) to reduce time to market. The digital circuit design lab is also the prerequisite for microcontrollers lab, embedded system design and VLSI designs.	**02**
01.	***Learning Objective/s:*** *To build and verify the prototype of digital control switches widely used in electrical devices and appliances such as stair case lamp, washing machines, automatic sectors, polling devices and water level controller.* **Contents:** Digital Control logic used in electrical switches, electrical appliances, polite devices, Functional requirement and safety features used in household equipment, Build and test the prototype of the design of digital controllers for switches, pilot devices, and house hold equipment using breadboard. **Experiment :**	**08**

	i. Realize the digital switch for stair case lamp. ii. To construct logic circuit of washing machine control using a basic. Washing Machine has three sensors for water level, door position and temperature. It has three output devices for control i.e., valve, heater and motor. iii. Realize the seat belt warning system using gates. iv. Realize the majority circuit using gates (Count of '1'). v. Realize the water level controller using AND and NOT gate.	
	Self-Learning Topics: *Digital design on open source simulation tools / Virtual labs.*	
	Learning Outcomes : *A learner will be able to* *LO 1.1: Identify functional requirement of house hold equipment, and automotive sector related to safety. (P.I.-3.1.5)* *LO 1.2: Build the prototype of digital switches used for staircase lamp, pilot devices of washing machines, seat belt motor vehicles, water tanks. (P.I.-3.2.2)* *LO 1.3: Build the prototype of polling count. (P.I.-3.2.2)* *LO1.4: Select the electronics devices power supply, multi-meter, function generator. CRO to perform experiments(P.I.-4.1.3)* *LO 1.5: Test the prototype design using specified procedure and test vectors/pattern. (P.I.-4.2.1)*	
02.	***Learning Objective/s:*** *To design the combinational circuits i.e., adder, subtractor, code converter and encoder using hardware descriptive language and validate it using computer aided design tool.* **Contents:** Concurrent Verilog Construct for arithmetic operations, code converter, encoders and decoders, Test bench for combinational circuits, Verilog codes for arithmetic operations, code converter, priority encoders and decoders, Simulation tool for functional verification of Verilog codes.	**06**
	Experiment: i. Simulate the Verilog code for 4-bit adder/subtractor. ii. Simulate the Verilog code for code converter i.e. BCD to ASCII. iii. Simulate the Verilog code for priority encoders.	
	Self-Learning Topics: *Simulate the Verilog code for binary to gray code converter.*	
	Learning Outcomes : *A learner will be able to* *LO 2.1: Identify the Verilog construct to design combinational circuits such as adder, subtractor, code converters and priority encoders. (P.I.-5.1.1)* *LO 2.2: Identify the modern tools to edit, debug, test the Verilog code of combinational circuits. (P.I.-5.2.1)* *LO 2.3: Generate test bench to verify the Verilog code of combinational circuits. (P.I.-4.2.1)* *LO 2.4: Simulate the Verilog codes using simulator. (P.I.-4.3.1)*	
03.	***Learning Objective/s:*** *To design the sequential circuits i.e., flip flops, counter, memory and sequence detector using hardware descriptive language and validate it using computer aided design tool.* **Contents:**	**08**

	Sequential Verilog Construct for flip-flops, counter, memory and finite state machines,3.2 Test bench for sequential circuits, Verilog codes for flip flop , memory , counter, shift register	
	Experiment :	
	i. Simulate the Verilog code for D and T flip flops ii. Simulate the Verilog code for 4-bit binary counter. iii. Simulate the Verilog code for 16x8 Memory. iv. Simulate the Verilog codes for sequence detector.	
	Self-Learning Topics: *Simulate the Verilog code for JK flip-flop.*	
	Learning Outcomes : *A learner will be able to* *LO 3.1: Identify the Verilog construct to design sequential circuits such as flip-flops, counter and memory. (P.I.-5.1.1)* *LO 3.2: Identify the modern tools to edit, debug, test the Verilog code of sequential circuits. (P.I.-5.2.1)* *LO 3.3: Generate test bench to verify the Verilog code of sequential circuits. (P.I.-4.2.1)* *LO 3.4: Simulate the Verilog codes using simulator. (P.I.-4.3.1)*	
04	*Learning Objective/s:* *To design communication protocol using hardware descriptive language and validate it using computer aided design tool.* **Contents:** Communication Protocols: I2C, SPI, UART, Payload format, Applications of protocol.	**06**
	Experiment: Verilog design of any one communication Protocols such as SPI, I2C, UART etc.	
	Self-Learning Topics: *AMBA bus* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Design serial communication protocol using Verilog constructs. (P.I.-5.1.1)* *LO 4.2: Identify the modern tools to edit, debug, test the Verilog code of communication protocol. (P.I.-5.2.1)* *LO 4.3: Simulate the Verilog codes communication protocol using simulator. (P.I.-4.3.1)* *LO 4.4: Demonstrate the designed communication protocol in teams using test vectors. (P.I.-4.2.1) (P.I.-8.3.1)* *LO 4.5 : Prepare a report containing, methods, test results with conclusion (P.I.-9.1.2)*	
Total		**30**

Note: Minimum 09 experiments in which 4 experiments should be based on breadboard. The remaining 5 experiments should cover Verilog codes for combinational, sequential designs and communication protocol.

Performance Indicators:

P.I. No.	**P.I. Statement**
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
3.2.2	Build models/prototypes to develop diverse set of design solutions
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities

4.2.1 Design and develop an experimental approach, specify appropriate equipment and procedures, test vectors.

4.3.1 Use appropriate procedures, tools, and techniques to conduct experiments and collect data

5.1.1 Identify modern hardware and software engineering tools, techniques and resources for engineering activities.

5.2.1 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.

Course Outcomes: A learner will be able to -

1. Design digital control switches for electrical appliances. *(LO 1.1 ,LO 1.2 ,LO 1.3, LO 1.4,LO1.5)*
2. Develop Verilog codes of combinational circuits and simulate them for functional verification. *(LO 2.1 ,LO 2.2 ,LO 2.3, LO 2.4)*
3. Develop Verilog codes of sequential circuits and simulate them for functional verification. *(LO 3.1 ,LO 3.2 ,LO 3.3, LO 3.4)*
4. Illustrate the knowledge of Verilog language to develop digital communication protocols. *(LO 4.1 ,LO 4.2 ,LO 4.3, LO 4.4, LO 4.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLBC302.1			3	3							
ECLBC302.2				3	3						
ECLBC302.3				3	3						
ECLBC302.4				3	3			2	2		
Average			3		3			2	2		

Books :

1. Modern Digital Electronics, R. P. Jain, , Fourth Edition, 2009, Tata McGraw Hill Education
2. Digital Design With an Introduction to the Verilog HDL, VHDL, and System Verilog, Morris Mano Michael D. Ciletti, Sixth Edition, Pearson

Reference Books :

1. Fundamentals of Digital Circuits, Anand Kumar, Fourth Edition, 2018, PHI learning
2. Digital Fundamentals, Thomas L. Floyd, Eleventh GlobalEdition,2015, Pearson Prentice Hall
3. Digital Electronics Principles and Applications, Mandal, First Edition, 2010, McGraw Hill Education
4. A Verilog HDL Primer, J. Bhasker, Third Edition, 1997, Star Galaxy Press
5. Embedded System, Raj Kamal , Fourth Edition,2020, McGraw Hill

Other Resources :

1. Lab: https://www.vlab.co.in/broad-area-electronics-and-communications

2. "Using Practical Examples in Teaching Digital Logic Design", Dr. Joseph P Hoffbeck,University of Portland

A. IN-SEMESTER ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observation,interpret results/conclusion and prepare a brief report as per requirement

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Interpretation of digital design
- Results obtained
- Oral
- Students will be randomly allocated a problem statement to base on digital system design laboratory work. The students will be asked to find the design solution of the given problem statement. The proposed solution will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.
- Then the student will be allowed to start with the implementation/ verification of proposed digital design.
- Students will be allocated 1 hour to implement/ verify the digital design. The obtained result is verified by both the examiners for its correctness. The weightage of the implementation/verification is 10 Marks
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
SBL	ECSBL301	Python Laboratory	02

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total Marks**
50	50	100

Pre-requisite:

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 5: Engineering tool usage
6. PO 8: Individual and Collaborative teamwork
7. PO 9: Communication
8. PO 11: Life-long learning.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python.
3. Infer the Object-oriented Programming concepts in Python.
4. Formulate GUI Programming and Databases operations in Python.

Module	Details	Hrs.
	Course Introduction Python programming has a significant scope in the field of Electronics and Telecommunication (EXTC). It is widely used for tasks such as data analysis, signal processing, automation and control systems design. With its extensive libraries like NumPy and SciPy, Python facilitates efficient processing of signals and data in EXTC applications. It is a high-level programming language known for its simplicity. It has a huge library resource which is used for applications like web development and data analysis to machine learning and artificial intelligence. It has a community driven development model.	**02**
01.	**Basics of Python programming** ***Learning Objective:*** *Apply knowledge of Python programming to analyze engineering problems using modern tools.*	**16**
	Contents: Introduction to Python, Installation and resources, Identifiers and	

	Indentation, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input statements in python. Data types (tuples, strings, dictionaries, lists), Operators in python (Arithmetic, relational, assignment, logical, bitwise, ternary), Decision Flow Control Statements, Methods and functions, Classes and objects, Files processing and handling functions.	
	Tasks: 1. Usage of Flow control statements. For example: a. Declare your Sem I SGPA value and Sem II SGPA value. Compute $CGPA = (SGPA1 * SGPA2)/2$ b. Display the result. Identify an appropriate flow control statement and display whether you are a distinction/1st class/second class holder. c. Accept user-defined values of distance between your institute and college canteen, write a program to convert and print this distance in meters, feet, inches and centimeters. Select an appropriate flow control statement and compute the following: If the walking speed of the student is 5Km/hr, calculate the time taken to reach the canteen. 2. Creation and Usage of Functions. For example: a. Write a function to generate the first 20 terms of the Fibonacci series. b. Use a list comprehension to convert temperatures in °C to Fahrenheit. c. Write a function that computes the volume of a sphere given its radius. d. Write a function to check if the given string is a Palindrome or not. 3. Creation and usage of classes For example: a. Create a Bank account class. The Class has two attributes: i. Owner ii. Balance: iii. And two methods: iv. Deposit v. Withdraw vi. Add banking details of 10 customers, make multiple withdrawals and deposits and display the final bank balance. 4. Handling of Files For Example: a. Sort City Names from the given file alphabetically. b. Create a new text editor file. Enter the values of temperature in degree Celsius and Fahrenheit.	

	c. Using RegEx, extract email and phone numbers from the given csv/text file.	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental programming concepts to solve problems. (P.I. 1.3.1)* *LO 1.2: Apply concepts of object-oriented programming to solve problems. (P.I. 1.4.1)* *LO 1.3: Comparison of flow control methods to arrive at solutions. (P.I. 2.2.4)* *LO 1.4: Identify existing processes for calling functions, creating classes and handling files. (P.I. 2.2.3)*	
02.	**Usage of Packages and libraries in Python** ***Learning Objective:*** *Identify the appropriate library and package for arithmetic analysis, data visualization, statistics, and development of GUI.*	**20**
	Contents: Use of numpy for arithmetic operations, Use of pandas to access and analyze csv files, Use of Matplotlib library, Scipy library for data visualization and analysis (statistics), Seaborn library for linear and logistic regression, Tkinter library for development of GUI, OpenCV library for image processing.	
	Tasks: 1. GUI development For example: a. Develop a GUI based calculator which has features to execute b. mathematical operations on matrices. The calculator should be able c. to handle complex numbers too. d. Develop a user registration form to opt for railway concession from e. college. 2. Analysis of csv files. For example: Import the e-commerce purchases CSV file and report the following: a. What are the highest and lowest Purchase Prices? b. How many people have the job title ‘Doctor'? c. How many people made the purchase during AM and how many people made the purchase during PM? d. What are the 5 most common job titles? e. Identify the purchase made from Lot: “90 WT”, what was the f. Purchase Price of the transaction? g. Obtain the email-Id of the person with the following Credit Card	

	Number: 4926535242672853. h. Calculate the number of people having American Express as their Credit Card Provider and one who has made a purchase above $ 95. i. How many people have a credit card that expires in 2025? j. What are the top 5 most popular email providers/ hosts? 3. Perform linear regression on the given data. For example: Import and read the Ecommerce Customers csv file and execute the following tasks: a. Display the heading and details of the file b. Create a jointplot to compare any two parameters/ characteristics from the csv file. c. Create a lmplot to predict on the correlation between any two parameters. d. Create a pair plot on the dataset. e. Import the training model and perform linear regression on the data. f. Apply logistic regression and predict whether a person will default on his loan. 4. Image processing For example: a. Take your own image and print its shape, pixel intensity of a small section, overwrite the pixel values, crop the margin and also reverse the image in the y-direction and display the final output.	
	Self-Learning Topics: *Implementing logistic regression/ polynomial regression.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Develop a GUI using python for requirements of given problem. (P.I.3.3.3)* *LO 2.2: Use Numpy and Pandas tools to solve mathematical problems. (P.I. 5.1.2)* *LO 2.3: Demonstrate proficiency in using packages and tools of python library. (P.I. 5.2.2)* *LO 2.4: Identify existing method and select an appropriate package for a given task and use the inbuilt methods. (P.I. 2.2.3)* *LO 2.5: Apply engineering mathematics and computations to solve regression models and analyze the given data for correlation. (P.I. 2.4.1, P.I.4.3.2)* *LO 2.6: Use the packages and tools for image processing. (P.I. 4.1.2)*	
03.	**Python for embedded systems** ***Learning Objective:*** ***Develop a standalone embedded system for societal benefits using python.***	**12**

	Contents: Sensing (Data acquisition using Rpi), Storage (Uploading data to cloud), Actuation (Ringing of alarm based on threshold levels of the sensed parameter.)	
	Tasks: 1. Acquire data from the given sensor. For example: a. Write a code to capture and store images on an embedded system. b. Write a code to acquire data from LM35 sensor. c. Write a code to acquire data from DHT11 sensor. 2. Store the acquired data on a cloud. 3. Read data from the cloud and actuate an alarm on predetermined conditions.	
	Self-Learning Topics: ***Introduction of data processing in Rpi, Architecture and Pinout diagram of Raspi 3.***	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify relevant data from the given specification sheets for design of simple data acquisition system. (P.I. 3.3.3)* *LO 3.2: Identify the suitable criteria for selection of components. (P.I. 3.2.3)* *LO 3.3: Develop ability to learn independently, with respect to integration of cloud environment with Python. (P.I. 11.1.3)* *LO 3.4: Use appropriate versions of Microcontroller for given task. (P.I. 11.2.2)*	
04.	**Course project** ***Learning Objectives:*** ***To develop a need-based application using python.***	**10**
	Contents: A python-based project.	
	Suggestive list of course projects: 1. A GUI based Personal expense tracker with authentication and currency converter feature. 2. Prototype of biometrics with face recognition. 3. A GUI based To-Do list with Authentication and reminder feature. 4. Number plate recognition using image processing. 5. Real-time language translation application. 6. Library management system with connection to database. 7. Simple Web scraper for stock market analysis 8. A To-do list with reminder feature	
	Self-Learning Topics: *Product sheet of the embedded system and the I-O peripherals.*	
	Learning Outcomes: *A learner will be able to*	

	LO 4.1: Identify the suitable criteria and user requirement to arrive at design solutions for a specific course project. (P.I. 3.2.2) *LO 4.2: Identify the suitable criteria for selection of components for building a course project. (P.I. 3.2.3)* *LO 4.3: Demonstrate effective communication, problem-solving, conflict resolution and leadership skills during the course project. (P.I. 8.2.1)* *LO 4.4: Present results as a team, with smooth integration of contributions from all individual efforts after completion of course project. (P.I. 8.3.1)* *LO 4.5: Create a clear, well-constructed, and well-supported course project report. (P.I. 9.1.2)* *LO 4.6: Create engineering-standard figures, reports, and tables to complement writing and presentations for the course project. (P.I. 9.3.1)*	
	Total	**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
3.2.2	Build models/prototypes to develop diverse set of design solutions.
3.2.3	Identify suitable criteria for evaluation of alternate design solutions.
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources).
4.1.2	Examine the relevant methods, tools, and techniques of experiment, design, system calibration, data acquisition, analysis and presentation.
4.3.2	Analyse data for trends and correlations, stating possible errors and limitations.
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems.
5.2.2	Demonstrate proficiency in using discipline specific tools.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.

9.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations.

11.1.3 Develop ability to learn independently through methods distinct from instructor provided materials.

11.2.2 Adapt to the current technologies regarding new developments in relevant field.

Course Outcomes: A learner will be able to -

1. Execute flow control statements, functions and objects on different data types in python. (*LO 1.1- LO 1.4*)
2. Demonstrate usage of libraries for computations and analysis. (*LO 2.2, L.O 2.3, LO 2.5, L.O 2.6*)
3. Develop GUI Applications in Python. (*LO 2.1, L.O 2.4*)
4. Develop python programs, specifically for embedded system. (*LO 3.1- LO 3.4*)
5. Develop a python-based application project. (*LO 4.1- LO 4.6*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECSBL301.1	3	3									
ECSBL301.2		2		3	3						
ECSBL301.3		2	2								
ECSBL301.4			3								3
ECSBL301.5			3					3	3		
Average	3	2	3	3	3			3	3		3

Text Books :

1. "Let us Python: Python is Future, Embrace it fast", Yashavant Kanetkar, 1st edition, 8 July 2019, BPB Publications.
2. "Python 3 object-oriented Programming", Dusty Phillips, 2nd Edition, August 2015, PACKT Publisher.
3. "Core Python Programming", Dr. R. Nageswara Rao, Dreamtech Press
4. "Beginning Python: Using Python 2.6 and Python 3.1", James Payne, Wrox publication.
5. "Introduction to computing and problem-solving using python", E Balagurusamy, McGraw Hill Education.
6. "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code", Zed A. Shaw, 3rd edition, 1 October 2013, Addison Wesley.

Reference Books :

1. "Python Crash Course A hands-on, Project Based Introduction to programming", Eric Matthes, 1st edition, 8 December 2015, No Starch Press.
2. "Headfirst Python", Paul Barry, 2nd edition, 16 December 2016, O′Reilly.
3. "Introduction to Machine Learning with Python", Andreas C. Mueller, 1st edition, 7 October 2016, O′Reilly.
4. "Python Cookbook: Recipes for Mastering Python 3", David Beazley and Brian K. Jones, 3rd edition, 10 May 2013, O'Reilly Media.
5. "Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as

you design, implement, and deliver 10 real world application", Bhaskar Chaudhary, November 30, 2015, Packt Publishing.

Other Resources :

1. W3Schools Online Web Tutorials: https://www.w3schools.com/python/default.asp
2. Python 3 Documentation: https://docs.python.org/
3. Spoken tutorial: https://spokentutorial.org/watch/Python+3.4.3/Getting+started+with+IPython/English/
4. Numpy Documentation: https://numpy.org/doc/
5. Pandas Documentation: https://pandas.pydata.org/docs/
6. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
7. Scipy Documentation : https://www.scipy.org/docs.html
8. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
9. Online course on Python: https://archive.nptel.ac.in/courses/106/106/106106182/

A. IN-SEMESTER ASSESSMENT (50 Marks)

1. Continuous assessment of Tasks Executed (30 Marks)

Students will be assigned tasks from the list given in syllabus. They have to perform the tasks, and get the desired output.

Students will be evaluated based on following:

i. Logic building for the given task (10 marks)
ii. Rectifying logical errors and syntax errors (06 marks)
iii. Well-structured and organized program (06 marks)
iv. Verification of experiment output for different inputs (08 marks)

2. Practical Test (15 Marks)

Practical examination on first 50% of the practical list will be conducted for one-and-a-half-hour. Students will be randomly allocated a task from the list of tasks. Evaluation will be done by Internal Examiner as follows:

Algorithm: 5 marks
Program execution and presentation of results and their interpretation: 5 marks
Oral Examination: 5 marks

Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical and Oral Exam) (50 Marks)

Students will be assessed based on three parameters:

- Concept/Algorithmic knowledge
- Practical programming knowledge
- Oral

- Students will be randomly allocated a program from the list of laboratory exercises and will be asked to write appropriate algorithm for the same. The algorithm is checked by the examiners (Internal and External) and evaluated out of 05 Marks.
  Then the student will be allowed to start with the implementation of the program.
- Students will be allocated 1 hour to complete the execution. The program is then checked by both the examiners for its correctness. The weightage of the program implementation is 20 Marks. The weightage of Observations, Interpretation and Conclusion written on paper will carry 05 Marks.
- Students will then be appearing for Oral Examination in front of both Internal and External examiners. The weightage of Oral will be of 20 Marks

Course Type	Course Code	Course Name	Credits
MNP	ECMNP301	Mini Project 1A	01

Examination Scheme	
Continuous Assessment	**Total**
50	50

Pre-requisite:

1. ESC203-Basic Electronics Engineering
2. ESL203-Basic Electronics Engineering Laboratory

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer & World
7. PO7: Ethics
8. PO8: Individual & Collaborative team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To familiarize students about available infrastructure at Department/Institute level, online resources, plagiarism, expectations from MP 1A.
2. To guide students in identifying societal or research needs and formulating them into problem statements.
3. To facilitate problem-solving in group settings.
4. To apply basic engineering principles to address identified problems.
5. To foster self-learning and research skills.

Guidelines for the Mini Project

1. At the beginning of semester-III, project guides are required to conduct around 4 hours' orientation sessions including following topics:

- Familiarizing students about infrastructure available at Department/Institute level and how to use it.
- How to identify societal problems and formulate project problem statement.
- How to carry out literature survey.
- What is plagiarism and what care needs to be taken while writing a report.
- What is project report template and how it should be used.
- What are expectations from mini-projects 1A.

2. Mini project may be carried out in one or more form of following:
Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software

development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

3. Students must form groups of 3 to 4 members either from the same or from different departments.

4. Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.

5. An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.

6. Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.

7. Faculty input should emphasize guiding by faculty and self-learning by group members.

8. Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.

9. The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Research papers, competition certificates may be submitted as part of annexure to the report.

10. With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.

11. However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Total hrs : 45

Course Outcomes:
Students will be able to –

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
    - Research/white paper/article/blog writing/publication, etc.
    - Business plan for entrepreneurship product creation
    - Patent filing/copyright.

8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester III (50 marks):
    - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
    - 20 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
    - 20 marks for the Final Report & Presentation
    - 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester III:

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
    - The first review will focus on finalizing the problem statement (topic approval).
    - The second review will centre on finalizing the proposed solution.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

Course Type	Course Code	Course Name	Credits
HSS	HSS301	PRODUCT DESIGN	02

Program Outcomes addressed:

1. PO2 Problem analysis
2. PO3 Design/Development of solutions
3. PO5 Engineering tool usage
4. PO6 The engineer and the world
5. PO7 Ethics
6. PO8 Individual and collaborative team work
7. PO10 Project management & finance
8. PO11 Life-long learning

Course Objectives:

1. Understand the product design process and its user-centered principles.
2. Apply fundamental design principles to create innovative product designs.
3. Demonstrate proficiency in generating and evaluating design concepts through ideation techniques.
4. Evaluate and synthesize sustainable and user-centric design practices in product development.

Module	Details	Hrs.
	Course Introduction – The course Product Design provides a thorough understanding of the principles, methods, and methodologies used in developing unique and functional products. Whether you want to be an industrial designer, a UX/UI specialist, or a creative problem solver, this course will provide you the necessary knowledge and abilities to envision, develop, and revise products that fulfill user needs and market demands. Students will investigate many areas of product design, such as aesthetics, usability, and sustainability, using both theory and hands-on practice. Design thinking, prototyping, and research will demonstrate to students how to turn ideas into concrete things that improve user experience and address real-world challenges.	**01**
01.	**Introduction to Product Design** ***Learning Objective:*** *Understand the fundamental principles and key elements that contribute to effective product design.*	**3-5**
	Contents: Overview of product design process, Importance of user-centered design, Design thinking methodologies, Case studies of successful product designs, Introduction to design tools and software (e.g., Sketch, Adobe XD)	

	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply design thinking methodologies to develop user-centered solutions.* (*P.I.- 2.1.1, 2.3.1, 3.2.1, 3.3.1*) *LO 1.2: Gain introductory experience with digital design tools.* (*P.I. – 5.1.1, 5.2.1*)	
02.	**Design Principles and Fundamentals** ***Learning Objective:*** *Understand and apply core design principles to create functional and aesthetically pleasing products.*	**5-7**
	Contents: Understanding design principles (e.g., balance, hierarchy, contrast), Human factors in design (ergonomics, anthropometrics), Material selection and properties, Basics of aesthetics and styling, Hands-on exercises in sketching and prototyping	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental design principles such as balance, contrast, proportion, and harmony to create aesthetically and functionally effective designs.* (*P.I. – 3.1.5, 3.2.3, 6.1.1*) *LO 2.2: Analyze and evaluate design elements to develop user-centered solutions that enhance usability, accessibility, and overall user experience.* (*P.I. – 3.1.1, 6.2.1*)	
03.	**Concept Generation and Ideation** ***Learning Objective:*** *Develop creative ideas and transform them into viable product concepts through structured ideation techniques.*	**5-7**
	Contents: Techniques for brainstorming and idea generation, Sketching and visualization techniques, Developing design briefs and specifications, Evaluating and selecting design concepts, Design for X, Rapid prototyping methods (e.g., 3D printing, CNC machining)	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply various ideation techniques such as brainstorming, mind mapping, and SCAMPER to generate innovative and creative product concepts*. (*P.I. – 2.4.4, 3.1.6, 3.2.1*) *LO 3.2: Develop and evaluate multiple design concepts based on user needs, feasibility, and functionality to refine ideas into viable solutions.* (*P.I. – 2.2.4, 3.1.1, 3.1.6*)	
04.	**Product Lifecycle** ***Learning Objectives:*** *Understand the stages of a product's lifecycle and how they influence design, development, and sustainability.*	**3-5**
	Contents: Detailed overview of the product development lifecycle, Cost estimation and budgeting, Marketing and Market research, Regulatory and compliance requirements (e.g., safety standards)	

	Learning Outcomes: *A learner will be able to* *LO 4.1: Understand and analyze the stages of the product lifecycle and their impact on design, marketing, and sustainability decisions.* (*P.I. – 3.1.1, 3.1.6, 6.3.2, 11.3.2*) *LO 4.2: Analyze the influence of lifecycle considerations such as material selection, manufacturing processes, and end-of-life disposal to develop sustainable and cost-effective product solutions.* (*P.I. – 3.1.5, 6.3.1, 6.4.1, 6.4.2, 11.1.1, 11.2.2*)	
05.	**User Experience (UX) Design** ***Learning Objective:*** *Design intuitive and user-friendly products by applying UX principles and usability testing.*	**3-5**
	Contents: Understanding user needs and behaviour, Usability testing and feedback gathering, Wire-framing and prototyping for digital products, Iterative design process, Accessibility and inclusive design principles	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply UX design principles such as usability, accessibility, and interaction design to create intuitive and user-friendly products.* (*P.I. – 3.1.6, 3.3.1, 5.2.2*) *LO 5.2: Conduct user research and usability testing to analyze user needs, gather feedback, and refine designs for an enhanced user experience.* (*P.I. – 3.1.1, 3.1.6, 5.1.2, 5.2.1, 10.3.1, 10.3.2*)	
06.	**Sustainability in Product Design** ***Learning Objective:*** *Incorporate sustainable practices and materials to create environmentally responsible product designs.*	**3-5**
	Contents: Environmental impact assessment in product design, Sustainable materials and manufacturing processes, Design for disassembly and recycling, Circular economy principles Case studies of eco-friendly product designs.	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply sustainable design principles by selecting eco-friendly materials, optimizing manufacturing processes, and minimizing environmental impact throughout the product lifecycle.* (*P.I. – 3.1.5, 6.3.2, 7.1.1, 11.3.1*) *LO 6.2: Assess the lifecycle impact of products in terms of resource consumption, carbon footprint, and end-of-life disposal to develop eco-friendly and socially responsible design solutions.* (*P.I. – 3.4.1, 6.4.1, 7.2.2, 11.3.2*) *LO 6.3: Demonstrate good communication and collaboration with interdisciplinary teams by incorporating sustainable design concepts, explaining environmental and social implications, and enabling cross-disciplinary discussions to create new, eco-friendly product solutions.* (*P.I. – 8.2.1, 8.3.1*)	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.1	Articulate problem statements and identify objectives.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.1	Recognize that need analysis is key to good problem definition.
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues.
3.1.6	Determine design objectives, functional requirements and arrive at specifications.
3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions.
3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development.
3.2.3	Identify suitable criteria for the evaluation of alternate design solutions.
3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
5.1.1	Identify modern engineering tools such as computer-aided drafting, 210odelling and analysis; techniques and resources for engineering activities.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) 210odelling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public.
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
6.4.1	Describe management techniques for sustainable development.
6.4.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives.
7.2.2	Examine and apply moral & ethical principles to known case studies.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
10.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
10.3.2	Use project management tools to schedule an engineering project, so it is completed on time and on budget.
11.1.1	Describe the rationale for the requirement for continuing professional development.
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
11.3.1	Source and comprehend technical literature and other credible sources of information.
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to –

1. Apply design thinking methodologies effectively to solve design problems. (*LO 1.1, LO 2.1, LO 2.2, LO 3.1, LO 3.2*)
2. Demonstrate proficiency in utilizing design tools and techniques for product development. (*LO 1.2, LO 5.1*)
3. Communicate and collaborate effectively for interdisciplinary teamwork. (*LO 6.3*)
4. Create functional and aesthetically pleasing product designs. (*LO 5.2*)
5. Integrate sustainable and user-centric design principles into product development processes. (*LO 4.1, LO 4.2, LO 6.1, LO 6.2*)

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
HSS301.1	--	3	3	--	--	3	--	--	--	--	--
HSS301.2	--	--	3	--	3	--	--	--	--	--	--
HSS301.3	--	--	--	--	--	--	--	3	--	--	--
HSS301.4	--	--	3	--	3	--	--	--	--	3	--
HSS301.5	--	--	3	--	--	3	3	--	--	--	3
Average	--	**3**	**3**	--	**3**	**3**	**3**	**3**	--	**3**	**3**

Text Books :

1. "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger, published by McGraw-Hill Education; 7th edition (January 25, 2021).
2. "Engineering Design: A Project-Based Introduction" by Clive L. Dym and Patrick Little, published by Wiley; 4th edition (August 26, 2015).
3. "Universal Principles of Design" by William Lidwell, Kritina Holden, and Jill Butler, published by Rockport Publishers; Revised and updated edition (January 1, 2010).

Reference Books :

1. "Sketching: Drawing Techniques for Product Designers" by Koos Eissen and Roselien Steur, published by BIS Publishers; 2nd edition (March 1, 2011).
2. "Materials and Design: The Art and Science of Material Selection in Product Design" by Mike Ashby and Kara Johnson, published by Butterworth-Heinemann; 3rd edition (October 10, 2014).
3. "The Design of Everyday Things" by Don Norman, published by Basic Books; Revisedand expanded edition (November 5, 2013).

Other Resources :

1. NPTEL Course: Product Design and Development, Prof. Inderdeep Singh, IITRoorkee Weblink: https://onlinecourses.nptel.ac.in/noc21_me83/preview
2. NPTEL Course: Product Design and Innovation, By Prof. Supradip Das, Prof. Swati Pal, Prof. Debayan Dhar, IIT Guwahati, IIT Guwahati, Web link: https://onlinecourses.nptel.ac.in/noc21 de01/preview

Continuous Assessment – Theory - (50 Marks)

Suggested breakup of distribution

Multiple Choice Questions	10 Marks
Case Study	20 Marks
Group Project	15 Marks
Regularity and Active participation	05 Marks

Course Type	Course Code	Course Name	Credits
PCC	ECPCC405	Engineering Mathematics-IV	03+01*

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20 + 25*	30	50	1.5	2	125

*For Tutorial

Pre-requisite :

1. ECPCC301 Engineering Mathematics-III

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis

Course Objectives :

1. To provide the Basic knowledge on the concepts of mathematics pertaining to the field of engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of mathematics in the field of Engineering

Module	Details	Hrs
	Course Introduction Engineering Mathematics forms the backbone of Electronics and Telecommunication Engineering. Mathematical concepts are essential for modeling, simulating, and implementing innovative solutions in areas such as signal processing, communication networks, control systems, and electronic circuits. For example- 1. Application of probability and statistics in Engineering design and analysis. 2. Application of complex integration in control systems and signal processing. 3. Application of correlation and regression in analysing signals and assessing system performance. 4. Application of vector space techniques in efficient transmission and reception strategies.	**01-02**
01.	**Probability Theory and Random Variable**	**06-08**
	Learning Objective/s:	
	The learner will be able to analyze random variables using the basic theory of probability and will be able to apply various mathematical techniques in determining probability functions.	
	Contents:	
	Conditional Probability, Bayes Theorem, Total Probability Theorem, Definition of Random Variable, Types of Random Variable: Discrete and Continuous, Probability Mass and Density Function, Measures of Central Tendency and Dispersion.	
	Self-Learning Topics:	

	Cumulative Distribution and Density Function	
	Learning Outcomes :	
	A learner will be able to *LO 1.1: Identify independents sets and disjoint sets and use its knowledge in the context of conditional probability. (P.I.-2.1.3)* *LO 1.2: Apply mathematical techniques of union, intersection and addition of sets, numbers for finding probabilities of events using Bayes' Theorem and Total Probability Theorem. (P.I.-1.1.1)* *LO 1.3: Identify if a given Random variable is Discrete or continuous in nature using existing definitions and formulas from Probability. (P.I.-2.1.2)* *LO 1.4: Apply advanced mathematical techniques for finding Expectation, Variance, Probability density function and Probability distribution function. (P.I.-1.1.3)*	
02.	**Probability Distribution**	**06-09**
	Learning Objective/s:	
	Learner will be able to analyze and identify standard probability distribution functions and apply the knowledge of distribution for finding probabilities of various events.	
	Contents:	
	Binomial distribution, Poisson Distribution, Fitting of a Poisson Curve, Gaussian Distribution, Normal Distribution (Standard Normal distribution, Reverse problem of Normal distribution)	
	Self-Learning Topics:	
	Joint Probability Distribution	
	Learning Outcomes:	
	A learner will be able to *LO 2.1: Apply mathematical techniques of exponents, algebra and basic probability for finding the probabilities of various events using Binomial, Poisson and Normal Distribution. (P.I.-1.1.1)* *LO 2.2: Identify the area under a Standard Normal Curve (bounded or unbounded) and use its knowledge in the context of Normal Distribution. (P.I.-2.1.3)* *LO 2.3: Identify whether Poisson distribution or Normal Distribution is applicable to a given problem using basic definitions of distribution and the data inferred from the problem. (P.I.-2.1.2)* *LO 2.4: Apply the advanced mathematical techniques of statistics to find the distribution of probabilities when percentile of area under the curve is given.* *(P.I. -1.1.3)* *LO 2.5: Articulate the problem statements in way such that either normal distribution or reverse normal distribution is to applied. (P.I.-2.1.1)*	
03.	**Complex Integration-I**	**05-07**
	Learning Objective/s:	
	Learner will be able to analyze complex power series and determine the value of complex integration using Cauchy's Integral theorem and Cauchy's Integral formula.	
	Contents:	
	Line Integral, Cauchy's Integral theorem: Simple connected, multiply connected regions. Cauchy Integral formula (without proof). Taylor's and Laurent's series (without proof).	

	Self-Learning Topics: *Winding Numbers* ***Learning Outcomes*** *A learner will be able to* *LO 3.1: Apply mathematical techniques from calculus to evaluate line and contour integrals. (P.I.-1.1.1)* *LO 3.2: Apply advanced mathematical techniques of analytical functions to rewrite the complex functions in a way that Cauchy Integral formula can be used. (P.I.-1.1.3)* *LO 3.3: Identify whether Cauchy Integral Theorem or Cauchy Integral Formula is to be used depending on the points where the function does not exist. (P.I.-2.1.3)* *LO 3.4: Identify the terms with negative powers in the power series expansion of complex functions and use this knowledge in understanding Taylor and Laurent Series. (P.I.-2.1.2)*	
04.	**Complex Integration-II** ***Learning Objective/s:*** *Learner will be able to analyse various types of singularities and apply its knowledge in finding contour integrals.* **Contents:** Definition of Singularity, Definition of Zeroes and Poles of f(z). Residues, Cauchy's Residue Theorem (without proof), Application of Residue Theorem to evaluate real integrals. ***Self-Learning Topics:*** *Application of Residue Theorem to evaluate improper real integrals.* ***Learning Outcomes :*** *A learner will be able to* *LO 4.1: Identify the existence of limits near the point of singularity and use this knowledge in classifying the types of singularities. (P.I.-2.1.2)* *LO 4.2: Apply mathematical techniques of calculus to evaluate contour integrals using the knowledge of residues. (P.I.-1.1.1)* *LO 4.3: Identify the order of poles and apply this knowledge for finding residues of complex function. (P.I.-2.1.3)* *LO 4.4: Apply fundamentals of distance in checking whether the singularities lie inside or outside the contour. (P.I.-1.3.1)*	**05-07**
05.	**Correlation and Regression** ***Learning Objective/s:*** *Learner will be able to analyze the mathematical dataset given and apply techniques of correlation and regression to identify the relationships between variables from the dataset.* **Contents:** Correlation, Karl Pearson's coefficients of correlation(r), Spearman's Rank correlation coefficient (R): Repeated Rank, Non-repeated rank, Regression, Line of regression, Curve fitting: Linear and Second-Degree Curves. ***Self-Learning Topics:*** *Fitting of an exponential Curve* ***Learning Outcomes :***	**07-09**

	A learner will be able to *LO 5.1: Identify whether Karl Pearson's or Spearman's coefficient of correlation is to be used in establishing relationship between two variables depending on the dataset given. (P.I.- 2.1.3)* *LO 5.2: Apply basic mathematical techniques from algebra in finding the lines of regression and regression coefficients. (P.I.-1.1.1)* *LO 5.3: Identify whether a linear degree curve or a quadratic degree curve is to be fit for the given data set based on the knowledge of Curve Fitting (P.I.-2.2.2)* *LO 5.4: Apply fundamental concepts of simultaneous equations and use it for curve fitting. (P.I.-1.3.1)* *LO 5.5: Identify whether step deviation method or direct correlation methods are to be applied to obtain Karl Person's coefficient of correlation accurately. (P.I.-2.3.2)*	
06.	**Vector Spaces** ***Learning Objective/s:*** *The learner is expected to analyze vectors and apply the concepts of vector algebra in identifying vector spaces and vector subspaces.* **Contents:** Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. Orthogonal projection, Orthogonal Basis, Gram-Schmidt orthogonalization process for vectors. Vector spaces over real field, subspaces, Linear combinations, Spanning Set, Linear Independence and Dependence. ***Self-Learning Topics:*** *Orthonormal basis, Basis and Dimension.* ***Learning Outcomes :*** *A learner will be able to* *LO 6.1: Apply mathematical techniques of linear algebra and vector addition to find Orthogonal projections. (P.I.-1.1.1)* *LO 6.2: Identify if a given set is Linearly Independent or Dependent and use this knowledge to write vectors as linear combinations of each other. (P.I.-2.1.3)* *LO 6.3: Identify the axioms of closure, addition and scalar multiplication and use this knowledge for vector spaces (P.I.-2.1.2)* *LO 6.4: Apply advanced mathematical knowledge of vector spaces to identify and analyze vector subspaces. (P.I.-1.1.3)*	**07-09**
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques such as calculus, linear algebra, probability and statistics, Boolean algebra to solve problems.
1.1.3	Apply advanced mathematical techniques such as integral and differential equations to describe/solve/construct a mathematical model of a system.

1.3.1 Apply fundamental Engineering concepts to solve Engineering problems.

2.1.1 Articulate problem statements and identify primary objectives and key constraints.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.2 Identify/ assemble/integrate mathematical tools to information and resources.

2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required

Course Outcomes:

1. Analyse random variables and apply the concepts of probability for getting the spread of data. (*LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Analyse the mathematical problem given and apply the concepts of distribution in finding probabilities. (*LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5)*
3. Apply the concepts of Complex Integration for identifying and evaluating integrals, computing residues and evaluating various contour integrals. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Analyse and interpret the data using Correlation and Regression. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Analyse vectors in a given space and apply the concept of vector spaces and orthogonalization process in Engineering Problems. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC405.1	3	3									
ECPCC405.2	3	3									
ECPCC405.3	3	3									
ECPCC405.4	3	3									
ECPCC405.5	3	3									
Average	3	3									

Text Books :

1. Advanced Engineering Mathematics, H. K. Dass, Twenty-first Revised Edition, 2013, S.Chand and Company Ltd.

Reference Books :

1. Probability, Statistics and Random Processes, T Veerarajan, Second Edition, 2004, Tata McGraw-Hill Publishing Company Ltd.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Eight Edition, 2010, Wiley Eastern Limited
3. Complex Variables and Applications, S. Ponnusamy and Herb Silverman, First, 2006, Birkhauser Boston
4. Higher Engineering Mathematics, Dr. B. S. Grewal, Forty Second Edition, 2017, Khanna Publication
5. Linear Algebra, Seymour Lipschutz and Marc Lipson,Forth Edition,2009, Tata McGraw-Hill Publishing Company Ltd.

Other Resources :

1. NPTEL Course: Probability and Statistics By Dr. Somesh Kumar, Department of Mathematics, IIT Kharagpur :-Web link- https://youtu.be/VVYLpmKRfQ8?si=Gh3EtQrLSrEFZMNo

2. NPTEL Course: Complex Analysis by Prof. P. A. S. Sree Krishna, Department of Mathematics, IIT Guwahati :-Web link https://youtu.be/Mwpz1zjPlzI?si=JU090YU2-MxJOXJD

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 MARKS)

One MCQ test as per Gate exam pattern/ level: 5 Marks
One Class test: 5 Marks
One Team-pair- Solo: 5 Marks
Regularity and attentiveness: 5 Marks

Continuous Assessment - Tutorial (25 MARKS)

Minimum six Tutorials: 20 Marks

Students must be encouraged to write at least 6 class tutorials. At least 6 Class tests will be conducted based on class tutorials on entire syllabus. Each class tests carries 20 Marks. Average will be taken of all class tests.

Regularity and attentiveness: 5 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% of the syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC406	Linear Integrated Circuits	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESC102- Basic Electrical Engineering
2. ESC203-Basic Electronics Engineering
3. ECPCC303 -Electronic Devices and Circuits

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO8: Individual and teamwork

Course Objectives:

1. To impart the knowledge to demonstrate competence in comprehending the concepts of operational amplifiers and design operational amplifier based applications.
2. To impart the knowledge to demonstrate the ability to design filters, oscillators, waveform generators and precision rectifiers using operational amplifiers.
3. To demonstrate the ability to execute a solution process to design Team-based project using IC555.
4. To demonstrate the ability to execute a solution process to analyse voltage regulator integrated circuits.
5. To introduce the special purpose integrated circuits like voltage-controlled oscillators and phase-locked loop.

Module	Details	Hrs.
	Course Introduction This course covers concept of operational amplifier which is an integrated circuit and its applications. Course also discusses some special purpose integrated circuits. Next Generation Integrated Circuit market is the growing preference for sustainable and eco-friendly products. It is escalating the integration of technology to enhance product quality and efficiency. The fundamental concepts of this subject are essential for designing operational amplifier (integrated circuit) based applications which are used extensively in mathematical computations, electronic systems such as audio communication, radio communication, medical electronics instrumentation and in many signal processing applications.	**01**
01.	**Introduction to Operational Amplifier**	**6-8**

	Learning Objective: *To demonstrate competence in engineering fundamentals and specialized engineering knowledge to comprehend the characteristics and configurations of operational amplifiers.*	
	Contents: Block diagram of operational amplifier. Ideal and practical characteristics of operational amplifier, Configurations of operational amplifier: Open loop and closed loop configurations of operational amplifier, application of negative feedback in amplifiers, effect on gain, bandwidth, input resistance, and output resistance, CMRR, Slew rate, PSRR.	
	Self-Learning Topics: *FET Amplifier.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to comprehend the working principle and characteristics of an op-amp. (P.I.-1.3.1)* *LO 1.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend open and closed loop configurations of an op-amp.* *(P.I.-1.4.1)*	
02.	**Applications of Operational Amplifier** ***Learning Objective:*** *To Demonstrate the ability to generate alternative design solutions using operational amplifiers.*	**7-9**
	Contents: Inverting and non-inverting configuration of operational amplifier, buffer, summing amplifier, difference amplifiers and Instrumentation amplifier using operational amplifier, Integrator & differentiator (ideal & practical), Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	Self-Learning Topics: *Audio amplifiers in a home stereo.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Determine design objectives, functional requirements and arrive at specifications using operational amplifiers. (P.I.-3.1.6)* *LO 2.2: Apply mathematical techniques and formal design principles to build op-amp based applications. (P.I.-3.3.3)*	
03.	**Filters, Waveform Generators, Oscillators & Precision rectifiers using operational amplifier** ***Learning Objective:*** *To Demonstrate the ability to generate filters, oscillators, waveform generators and precision rectifiers using operational amplifier.*	**7-9**
	Contents:	

	Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters. Concept of Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator. Waveform generators: Square wave generator and triangular wave generator, Basics of Precision Rectifiers: Half wave and full wave precision rectifiers.	
	Self-Learning Topics: *Analog to Digital converters.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Determine functional requirements of negative feedback to design filters, waveform generators and rectifiers. (P.I.-3.1.6)* *LO 3.2: Apply formal design principles to make use of positive feedback to design opamp based oscillators. (P.I.-3.3.3)*	
04.	**Timer IC 555 and it's applications** ***Learning Objectives:*** *1. To demonstrate the ability to design multivibrators using IC 555.* *2. Demonstrate effective individual and team operations--communication, problem-solving skills for implementing application of IC 555 in a team.*	**7-9**
	Contents: Functional block diagram and working of IC 555, Design of Astable and Monostable multivibrator using IC 555, Applications of Monostable multivibrator such as ramp genaration, frequency division and pulse – width modulation. Applications of Astable multivibrator such as FSK generator, Pulse position modulator and Schmitt trigger.	
	Self-Learning Topics: *Bistable mode of IC 555.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Determine functional requirements of monostable multivibrators for ramp generation, frequency division and pulse width modulation. (P.I.-3.1.6)* *LO 4.2: Apply formal design principles to build FSK generator, Pulse position modulator and Schmitt trigger. (P.I.-3.3.3)* *LO 4.3: Demonstrate effective communication in implementing application in a team using IC 555. (P.I.-8.2.1)* *LO 4.4: Present results as a team, with smooth integration of contributions from all individual efforts. (P.I.-8.3.1)*	
05.	**Voltage regulator integrated circuits** ***Learning Objective/s:*** *To identify the engineering systems, variables, and parameters for analyzing voltage regulator circuits.*	**5-7**
	Contents: Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series), LM317 Three terminal adjustable voltage regulator, Switched mode power supplies (SMPS).	

	Self-Learning Topics: *Switching voltage regulators.*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify engineering systems to solve the problems of voltage regulators. (P.I.-2.1.2)* *LO 5.2: Compare and contrast alternative solutions to select best voltage regulator as per requirement. (P.I.-2.2.4)*	
06.	**Special Purpose Integrated Circuits** ***Learning Objective/s:*** 1. *Demonstrate competence in specialized engineering knowledge to implement applications of VCO IC 566.* 2. *To identify the engineering systems, variables, and parameters for analyzing PLL IC 565.*	**5-7**
	Contents: Functional block diagram and working of Voltage-controlled oscillator (VCO) IC 566 and application as frequency modulator, Functional block diagram and working of Phase-locked Loop (PLL) IC 565 and application as FSK Demodulator.	
	Self-Learning Topics: *PLL frequency synthesizer.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply fundamental engineering concepts to comprehend the functional block diagram and working principle of IC 566. (P.I.-1.3.1)* *LO 6.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend functional block diagram and working principle of PLL IC 565. (P.I.-1.4.1)* *LO 6.3: Apply engineering computations to analyze parameters of VCO IC 566 and PLL IC 565. (P.I.-2.1.2)* *LO 6.4: Combine engineering concepts to formulate VCO IC 566 and PLL IC 566 to build frequency modulator and FSK demodulator resp. (P.I.-2.3.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and accepted practice areas to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.4	Compare and contrast alternative solutions to select the appropriate methodology.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
3.1.6	Determine design objectives, functional requirements and arrive at specifications

3.3.3 Identify relevant data from the given resources and arrive at a best fitting design solution for particular specifications.
8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

Course Outcomes: A learner will be able to -

1. Apply the fundamentals of engineering to understand the concepts of operational amplifiers. (*LO 1.1, LO 1.2*)
2. Analyse working of different applications of Opamp. (*LO 2.1, LO 2.2*)
3. Apply the fundamentals of engineering to design filters, oscillators, waveform generators and precision rectifiers using operational amplifiers. (*LO 3.1, LO 3.2)*
4. Apply fundamentals of engineering to analyse IC 555 applications and design Team-based project. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4*)
5. Summarize working of voltage regulators, voltage-controlled oscillators and phase locked loop. (*LO 5.1, LO5.2, LO 6.1, LO 6.2, LO 6.3, LO 6.4*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC406.1	3										
ECPCC406.2			3								
ECPCC406.3			3								
ECPCC406.4			3					3			
ECPCC406.5	3	3									
Average	3	3	3					3			

Reference Books :

1. Operation Amplifiers and Linear Integrated Circuits, David A. Bell, Indian Edition Oxford University Press.
2. Operation Amplifiers and Linear Integrated Circuits, R. F. Coughlin and F. F. Driscoll, 6th Edition, Prentice Hall.
3. Electronic Devices and Circuits, J. Millman, Christos C Halkias, and Satyabratatajit, Millman's, 3rd Edition, McGrawHill.

Other Resources:

1. NPTEL Course: Integrated Circuits and Applications by Prof. Prof. Shaik Rafi Ahamed, Department of Electrical Engineering IIT Guwahati: -
   Web link- https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. NPTEL Course: Analog Circuits, By Prof. Dr. Pramod Agarwal, IIT Roorkee:
   Web link- https://nptel.ac.in/courses/117107094 /

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution
a) Two Class tests: 10 marks
b) Open book test/ Open notes test: 05 Marks

c) Regularity and active participation: 05 Marks

2.Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.\

Course Type	Course Code	Course Name	Credits
PCC	ECPCC407	Principles of Communication	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESC203 - Basic Electronics Engineering
2. ECPCC303- Electronic Devices and Circuits

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO11: Life-long learning

Course Objectives:

1. To impart the fundamentals of basic communication system and importance of noise.
2. To teach various analog modulation and demodulation techniques.
3. To introduce the concept of radio receivers.
4. To develop the key concepts of analog and digital pulse modulation and demodulation techniques.

Module	Details	Hrs.
	Course Introduction The Principles of Communication Engineering course provides a fundamental understanding of the principles, techniques, and technologies involved in communication systems. This course typically covers topics related to the design, analysis, and implementation of communication systems used for transmitting and receiving information.	**01**
01.	**Basics of Communication Systems** ***Learning Objective:*** ***To impart knowledge on different types of communication mode and understand need of modulation.***	**3-5**
	Contents: Block schematic of communication system, Simplex and duplex systems, Modes of communication: Broadcast and point to point communication, Necessity of modulation, Classification of modulation, modulation index, bandwidth, voltage distribution and power calculations.	

	Multiplexing: Time division multiplexing, Frequency division multiplexing.	
	Self-Learning Topics: ***Radio frequency spectrum with its wavelength and corresponding application.***	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental concepts of modulation to solve problems related to efficiency. (P.I.- 1.3.1)* *LO 1.2: Apply concepts of different mediums that influence communications in diverse scenarios. (P.I.- 1.4.1)* *LO 1.3: Identify the variables and parameters related to modulation to solve problems related to depth of modulation in communication system (P.I.- 2.1.2)* *LO 1.4: Breakdown communication system into interconnected sub systems to analyze transmitters and receivers. (P.I.- 2.2.1)* *LO 1.5: Recognize the need of multiplexing to reduce the overall bandwidth of a system. (P.I.- 3.1.1)* *LO 1.6: Identify relevant examples of multiplexing in practical scenarios and arrive at an optimal design solution for multiplexing multiple voice signals in communication systems. (P.I.- 3.3.3)*	
02.	**Noise in communication system** ***Learning Objective:*** ***To interpret how noise affects signal quality and system performance in communication systems.***	**4-6**
	Contents: Sources of noise, Types of noise: Thermal, Shot, Transition, Partition, Flicker, transit-time, and atmospheric noise; signal to noise ratio, noise figure, noise temperature, system sensitivity and Friss formula.	
	Self-Learning Topics: ***Importance of white noise and tis spectrum.***	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental concepts of noise and its effect on communication systems. (P.I.- 1.3.1)* *LO 2.2: Compare and contrast different types of noise parameters that best define the noise in communication system. (P.I.- 2.2.4)* *LO 2.3: Identify sources of noise in the system and the limitations imposed due to its presence. (P.I.- 2.4.3)* *LO 2.4: Apply concepts of Friis formula to solve the problem in amplifiers. (P.I.- 1.4.1)*	
03.	**Amplitude Modulation and Demodulation** ***Learning Objective:*** ***To educate different terminology related to modulations and visualize the AM in time as well as frequency domain.***	**9-11**

	Contents: Amplitude modulation: Definition, expression, time and frequency domain, types: Double sideband full carrier (DSBFC), Double sideband suppressed. carrier (DSBSC), Single sideband suppressed carrier (SSBSC) and independent side band (ISB), Double sideband full carrier: Principles, low-level and high-level transmitters, Double sideband suppressed carrier: Balanced modulators and Single sideband systems: modulation schemes. Amplitude demodulation: Diode detector, practical diode detector, Standards amplitude modulation techniques. Concept of Vestigial sideband and independent sideband.	
	Self-Learning Topics: ***Pilot carrier system and its importance in communication system.***	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply the concepts of AM to determine bandwidth and power efficiency. (P.I.-1.4.1)* *LO 3.2: Apply fundamental concepts of vestigial sideband AM to solve the problem of bandwidth utilization of audio and video signals efficiently. (P.I.-1.3.1)* *LO 3.3: Compare and contrast different AM techniques to select the best method. (P.I.- 2.2.4)* *LO 3.4: Breakdown and analyze AM system to obtain AM wave equation. (P.I.- 2.2.1)* *LO 3.5: Adapt to the current technologies based on the development of AM systems in the communication field. (P.I.- 11.2.2)* *LO 3.6: Source and comprehend technical literature based on the Pilot carrier system and relate to the practical examples in AM receivers. (P.I.- 11.3.1)*	
04.	**Frequency Modulation and Demodulation** ***Learning Objectives:*** ***Comprehend the concept of frequency and phase modulation and evaluate all three types of modulation.***	**9-11**
	Contents: Frequency and phase deviation. Narrow Band Frequency modulation, Wide Band Frequency modulation, Varactor diode modulator, FET reactance modulator, Direct and indirect FM transmitter, noise triangle, preemphasis and de-emphasis. FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, amplitude limiting and thresholding, Comparison of analog modulation schemes.	
	Self-Learning Topics: ***Phase modulation system to generate FM indirectly.***	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the concepts of FM to determine bandwidth. (P.I.-1.4.1)* *LO 4.2: Apply fundamental concepts of noise triangle in FM to solve the problem of error by analyzing the degree of modulation. (P.I.-1.3.1)* *LO 4.3: Identify and integrate emphasis circuits to the FM systems. (P.I.-2.2.2)*	

	LO 4.4: Compare and contrast different analog modulation techniques to select the best method. (P.I.- 2.2.4) *LO 4.5: Breakdown and analyze FM system for FM wave equation. (P.I.-2.2.1)*	
05.	**Radio Receivers** ***Learning Objective/s:*** ***To instill knowledge on different receivers in communication systems and emphasize on the performance parameters of radio receivers.***	**6-8**
	Contents: TRF and Super-heterodyne receiver, Performance parameters: Image frequency rejection ratio (IFRR), sensitivity, selectivity, double spotting and fidelity; Choice of Intermediate Frequency, Image frequency, Automatic Gain Control, Automatic Frequency Control. Double conversion radio receiver.	
	Self-Learning Topics: ***Software defined radio and Amateur radio.***	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply the concepts of Radio receivers to determine parameters. (P.I.- 1.4.1)* *LO 5.2: Apply fundamental concepts of automatic gain control in radio receivers to solve the problem of gain control. (P.I.-1.3.1)* *LO 5.3: Produce and validate different indices related to radio receivers. (P.I.- 2.4.2)* *LO 5.4: Identify different receiver performance parameters and their impact on receiver operation. (P.I.- 3.3.3)* *LO 5.5: Recognize the need for double conversion receivers for the purpose of demodulation. (P.I.- 3.1.1)* *LO 5.6: Breakdown and analyze Radio receivers. (P.I.-2.2.1)*	
06.	**Pulse Modulation & Demodulation** ***Learning Objective/s:*** ***Emphasize on the sampling theorem and its application in communication systems.***	**6-8**
	Contents: Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing and aperture effect. Pulse amplitude modulation (PAM), Pulse width modulation (PWM) and Pulse position modulation (PPM) systems: Modulation and demodulation, Applications. Basics of Pulse code modulation system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM). Application of PCM.	
	Self-Learning Topics: ***Quantization error and its role in communication systems to overcome the step-size error. Applications of pulse modulation system.***	
	Learning Outcomes:	

	A learner will be able to *LO 6.1: Recognize the need of sampling at Nyquist rate and regenerate the modulating signal. (P.I.- 3.1.1)* *LO 6.2: Identify the type of pulse modulation system and analyze its use in communication. (P.I.- 2.1.2)* *LO 6.3: Extract understanding related to pulse modulation and its limitations. (P.I.-2.4.4)* *LO 6.4: Compare and contrast different pulse modulation techniques to select the best method. (P.I.- 2.2.4)* *LO 6.5: Determine design objectives of digital pulse modulation and its requirement to obtain an output with minimum quantization error. (P.I.- 3.1.6)* *LO 6.6: Adapt to the current technologies based on the development of digital systems and the importance of error in the communication field. (P.I.- 11.2.2)* *LO 6.7: Source and comprehend technical literature based on the quantization error and relate to the practical examples. (P.I.- 11.3.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.1	Breakdown complex problem into interconnected sub systems and analyse by proper assumptions/ justification from information and resources.
2.2.2	Identify/ assemble/integrate mathematical tools to information and resources.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.1	Recognize that need analysis is key to good problem definition.
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
11.2.2	Adapt to the current technologies regarding new developments in relevant field.
11.3.1	Source and comprehend technical literature and other credible sources of information.

Course Outcomes: A learner will be able to -

1. Examine the performance of Communication System in presence as well as in absence of noise.
   (*LO 1.2, LO 1.4 - LO 1.6, LO 2.1- LO 2.4*)
2. Analyse and compare types of analog modulation and demodulation.
   (*LO 1.1, LO 1.3, LO 3.1- 3.6 and LO 4.1- 4.5*)

3. Illustrate the working of analog communication transmitter and receiver systems. (*LO 5.1- 5.6*)
4. Analyse the pulse modulation techniques. (*LO 6.1- 6.7*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC407.1	3	3	3								
ECPCC407.2	3	3									3
ECPCC407.3	3	3	3								
ECPCC407.4		3	3								3
Average	3	3	3								3

Textbooks:

1. "Electronics Communication System", Kennedy and Davis, 4th edition, Tata McGraw Hill.
2. "Modern Digital and Analog Communication system", B.P. Lathi, Zhi Ding, 4th edition, OxfordUniversity Press.
3. "Electronics Communication Systems", Wayne Tomasi, fifth edition, Pearson education.

Reference Books:

1. "Taub's Principles of Communication systems", Taub, Schilling and Saha, 3rd edition, Tata McGraw Hill
2. "Communication Systems: Analog and Digital", P. Sing and S.D. Sapre, 3rd edition, Tata McGraw Hill
3. "Introduction to Analog and Digital Communication", Simon Haykin, Michel Moher, Second edition, Wiley.
4. "Electronic Communication ", Dennis Roddy and John Coolen, 4/e, 2011, Pearson.
5. "Communication Electronics", Louis Frenzel, Third Edition, Tata McGraw Hill.
6. "Introduction to Radio Communication Systems", Jack Smith, Second edition.

Other Resources:

1. **NPTEL/ Swayam Course:** Analog Communication by Prof. Goutam Das, IIT Kharagpur
   Web Link: https://swayam.gov.in/nd1_noc20_ee69/preview

A. IN-SEMESTER ASSESSMENT (50 MARKS)
1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) One MCQ test as per GATE exam pattern / level: 05 Marks
b) One Class test:05 Marks
c) Open notes test: 05 Marks
d) Regularity and active participation: 05 Marks

3. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC408	MICROCONTROLLER & EMBEDDED SYSTEM	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ESL103- C Programming Laboratory
2. ECPCC304 - Digital Circuit Design

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO6: The Engineer and Society
6. PO7: Ethics
7. PO8: Individual and Collaborative Teamwork
8. PO9: Communication

Course Objectives:

1. To learn the computer architectures, architectural comparison and its selection parameters.
2. To describe architectural building blocks of microcontrollers and its applications in microcontroller-based systems.
3. To describe architectural building blocks of ARM, processing modes and low-level instruction set in ARM environment.
4. To describe the embedded system designs.

Module	Details	Hrs
	Course Introduction Microcontrollers are widely used in embedded system designs such as mobile phones, medical equipment, entertaining gadgets and many more. Microcontrollers are employed in designing a system on chip (SoC) based around a microcontroller core and in designing microprocessor core itself. Microcontroller is also a foundation course for embedded systems, system on chip design and VLSI courses.	**01**
01.	**Microcontrollers and Microprocessors** ***Learning Objective/s:*** *To apply the knowledge of computer architecture, performance parameters and features of microprocessors and microcontrollers to design an embedded system.*	**4 - 6**

	Contents: Overview of Microprocessors and microcontrollers, Overview of Computer Architecture- Memory Architecture -Van Numan & Harvard, Core Architecture -Micro-coded & Hard-Wired Coded, Instruction Set Architecture- RISC & CISC, Multi Core, DSP, Indian Processors: Features of Ajit, Shakti Processors, Parameters to select a Microcontroller. ***Self-Learning Topics:*** *Course Architecture of 8-bit microprocessor -8085* ***Learning Outcomes :*** *A learner will be able to* *LO 1.1 Apply computer architectural concepts to identify components of different architectures. (P.I.-1.3.1)* *LO 1.2 Use core principles of engineering to differentiate microprocessors and microcontrollers. (P.I.-1.4.1)* *LO 1.3 Elicit the Indian microprocessors and there features suitable for embedded system applications. (P.I.-3.1.2) (P.I.-7.1.1) (P.I. 8.1.1) (P.I. 8.3.1) (P.I. 9.1.2) (P.I. 9.2.2)* *LO 1.4 Identify selection parameters of microcontroller for the design of embedded system. (P.I.-3.1.6)*	
02.	**ARM Microcontroller** ***Learning Objective/s:*** *To apply the knowledge of ARM and identify its applications in Medical field, entertaining gadget and communication devices.* **Contents:** Introduction to ARM, ARM Products, Intellectual properties of ARM, Applications of ARM cortex 'A', 'R' and 'M' series, architectural inheritance, ARM 7- Features, architecture- core data path, pipeline, Register Bank, Program Status Register, Program Counter, Exception Handling, Processor operating Modes and Register Set. ***Self-Learning Topics:*** *Find the role of ARM in Automobiles sector.* ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Identify the features of basic RISC machines for inclusion and exclusion from ARM architecture. (P.I.-2.2.4)* *LO 2.2: Identify and illustrate architectural component of ARM and ARM IP. (P.I.-2.2.2) (P.I.-6.2.1)* *LO 2.3: Identify the ARM cortex family used in featured rich OS, real time signal processing and low power applications. (P.I.-2.3.1)*	**8 - 10**
03.	**ARM 7 Instruction Set** ***Learning Objective/s:*** *To analyze the assembly language instruction set of the ARM to select the appropriate instruction for data processing, flow control and data transfer used in assembly language environment.* **Contents:** Addressing Modes, BIG and Little Endian formats, Data Processing Instructions, Conditional Codes, Conditional execution and flag, Branch	**8 - 10**

	Instructions, Barral Shifter, Load and store: Pre and post indexing, Multiplication, Software interrupts, Integrated design environment for ARM.	
	Self-Learning Topics: *High level language instructions used for ARM environment.* ***Learning Outcomes :*** *A learner will be able to* *LO 3.1: Select the appropriate assembly language instruction for logical, arithmetic shifts to solve mathematical equations. (P.I.-2.4.1)* *LO 3.2: Select the appropriate assembly language instruction for logical, Extract the result of ARM instruction. (P.I.-2.4.2)* *LO 3.3: Identify and describe the ARM instructions for data transfer. (P.I.-5.1.1)* *LO 3.4: Identify the strengths and limitations of IDE used in ARM development. (P.I.-5.2.1)*	
04.	**ARM-32 bit Cortex M4** ***Learning Objective/s:*** *To apply the knowledge of architectural components of 32bit cortex M4 family and identify the components to communicate with external peripherals.*	**6 - 8**
	Contents: Functional overview, Memory protection unit, embedded Flash and SRAM, Clock, Reset and Supply Power Management, Interrupts, GPIO configuration, ADC/ DAC supports, DMA, Timers and Watchdog, Communication Interfaces –I2C, USART, SPI.	
	Self-Learning Topics: *Serial communication protocol -Serial audio interface and CAN.* ***Learning Outcomes :*** *A learner will be able to* *LO 4.1: Apply the memory organization concept to avail the memory protection in RTOS environment. (P.I.-1.4.1)* *LO 4.2: Select timer configuration by applying PWM concept to obtain the desired triggering pulses for given applications. (P.I.-1.3.1)* *LO 4.3: Compare independent and windows watchdog timers present in ARM. (P.I.-2.2.4)* *LO 4.4: Identify the building blocks communication protocols used for serial communication. (P.I.-2.2.1)*	
05.	**I/O interfacing with ARM and High-Level Programming** ***Learning Objective/s:*** *To design ARM based system with I/O device interface and it's the high-level language program used by engineering tools for simulation.*	**6 -8**
	Contents: Key interface – Static and Multiplexed, Display Devices- LCD, 7 segment in Multiplexed mode, ADC /DAC configuration, Interrupts, UART, Timers	
	Self-Learning Topics: *Select any ARM development board and identify the I/O peripherals support available with board.* ***Learning Outcomes :***	

	A learner will be able to *LO 5.1: Design ARM based system to measure the physical parameters. (P.I.-3.1.6)* *LO 5.2: Design a serial communication interface by selecting appropriate mode. (P.I.-3.3.3)* *LO 5.1: Identify the display devices to interface with identified GPIO lines of ARM processor. Display the decimal numbers on 7 it using 'c' language program. (P.I.-5.1.1)* *LO 5.4 :Use multiplexed techniques to interface matrix key board with ARM. (P.I.-5.1.2)*	
06.	**Embedded Systems** ***Learning Objective/s:*** *To apply the knowledge ARM architecture to design embedded system.*	**6 - 7**
	Contents: Role of microcontrollers in Embedded System, Characteristics of Embedded Systems, Development process, Criteria for selecting microcontrollers in embedded system design, Applications of embedded systems like Adaptive Cruise Control (ACC).	
	Self-Learning Topics: *Overview of the building blocks of Embedded Systems* ***Learning Outcomes :*** *A learner will be able to* *LO 6.1: Identify the characteristics of embedded system. (P.I.-2.1.2)* *LO 6.2: Identify the role of /microcontroller in embedded system. (P.I.2.1.1)* *LO 6.3: Identify selection parameters of microcontroller for the design of embedded system. (P.I.-3.3.3)* *LO 6.4: Design embedded system based system for adaptive cruise control. (P.I.-3.1.6)*	
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.1	Breakdown complex problem into interconnected sub systems and analyse by proper assumptions/ justification from information and resources.
2.2.2	Identify/ assemble/integrate mathematical tools to information and resources
2.2.4	Compare and contrast alternative solutions to select the best methodology.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.1	Apply engineering mathematics and computations to solve mathematical models

2.4.2 Produce and validate results through skilful use of contemporary engineering techniques

3.1.2 Elicit and document, engineering requirements from stakeholders

3.1.6 Determine design objectives, functional requirements and arrive at specifications

3.3.3 Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.

5.1.1 Identify modern hardware and software engineering tools, techniques and resources for engineering activities.

5.1.2 Use/adapt/modify/create tools and techniques to solve engineering problems

5.2.1 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.

6.2.1 Comprehend legal requirements relevant to engineering design and propose solution complying to engineering standards.

7.1.1 Follow ethical practices to create a document.

8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.

9.2.2 Deliver effective oral presentations to technical or non- technical audiences.

8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team

Course Outcomes: A learner will be able to -

1. Illustrate the knowledge of Computer architectures used in microcontroller-based system.
   (LO 1.1 ,LO 1.2 ,LO 1.3, LO 1.4)
2. Illustrate the knowledge of ARM architecture and its processing modes.
   (LO 2.1 ,LO 2.2 ,LO 2.3))
3. Summarize the data processing, flow control, data transfer instructions of ARM processor.
   (LO 3.1 ,LO 3.2 ,LO 3.3, LO 3.4)
4. Summarize the functional blocks of ARM Cortex M4 series Microcontrollers.
   (LO 4.1 ,LO 4.2 ,LO 4.3, LO4.4)
5. Develop the high-level language programs to interface I/O devices and communication with external peripheral.
   (LO 5.1 ,LO 5.2 ,LO 5.3, LO5.4)
6. Illustrate the knowledge of microcontroller to design embedded system applications.
   (LO 6.1 ,LO 6.2 ,LO 6.3, LO6.4)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC408.1	3		3				2	3	3		
ECPCC408.2		3				2					
ECPCC408.3		3			3						
ECPCC408.4	3	3									
ECPCC408.5			3		3						
ECPCC408.6		3	3								
Average	3	3	3		3	2	2	3	3		

Text Books:

1. ARM System Developer's Guide: Designing and Optimizing System Software, Andrew N. Sloss, Dominic Symes and Chris Wright,2nd edition,2004, Morgan Kaufmann Publisher.
2. ARM system on-chip architecture, Steve Furber, Addison Wesley, second edition, 2000.
3. ARM Microcontroller Interfacing: Hardware and Software", Warwick A. Smith, 2010, Delmar Cengage Learning.

Reference Books :

1. Microcontroller Technology: The 68HC1, Peter Spasov,4th edition,1999, Prentice Hall
2. Embedded Systems: Introduction to Arm Cortex-M Microcontrollers, Jonathan Valvano,5th edition, 2012, Create Space Independent Publishing Platform.
3. Embedded Systems: Architecture, Programming, and Design, Raj Kamal, 3rd Edition, 2017, McGraw-Hill Education.
4. Microcontrollers, Ariel Lutenberg, Pablo Gomez, Eric Pernia,2022, Arm education Media.

Other Resources :

1. Forums and communities. (Microchip Forum, STM32 Community) Web link: https://academy.st.com/s/learning-catalogs
2. ARM Architecture Reference Manuals, keil Development tools -ARM Documentation. Web link:https://developer.arm.com/documentation/ddi0487/latest/
3. Web link for Indian Shakti processor: https://shakti.org.in/processors.html.

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution
Design assignment on embedded system application*:10 Marks
Article reading & summarization/poster creation: 05 Marks
Regularity and active participation:05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B.END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30 % weightage, and the syllabus covered from MSE to ESE carrying 70 to 80% weightage.

* Topics: Embedded system application such as controlled rectifiers, speed control of industrial drives, choppers. However, students are free to select any application with prior approval from the course coordinator.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC403	LINEAR INTEGRATED CIRCUITS LABORATORY	01

Examination Scheme		
Continuous Assessment	**End-Semester Examination (ESE)**	**Total**
25	**25**	**50**

Pre-requisite:

1. ESL206 -Basic Electronics Engineering Laboratory
2. ECLBC301- Electronic Devices and Circuits Lab

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO5: Engineering tool usage
5. PO8: Individual and Teamwork
6. PO9: Communication

Course Objectives:

1. To analyse open and closed loop configurations of operational amplifier
2. To summarize various linear and non-linear applications of operational amplifier
3. To develop design skills related operational amplifier and IC-555 Timer IC.

Module	Details	Hrs.
	Course Introduction This course covers concept of operational amplifier which is an integrated circuit and its applications. operational amplifier are used extensively in mathematical computations, electronic systems such as audio communication, radio communication, medical electronics instrumentation and in many signal processing applications. Course also discusses some special purpose integrated circuits.	**01**
01.	**Introduction to Operational Amplifier** ***Learning Objective/s:*** ***Comprehend various configurations of operational amplifier, circuits associated with closed loop configurations and derive suitable conclusion and relate it with theoretical concepts.***	
	Suggested Experiments: 1. Proof of concept: Inverting Amplifier 2. Proof Concept: Non-inverting amplifier 3. Proof of Concept: Buffer Design of an analog calculator using operational amplifier	**06**

	Self-Learning Topics: ***Learn the various applications based on inverting and non-inverting operational amplifier***	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Comprehend and realize the various closed loop configuration of operational amplifier (P.I 1.3.1, PI 1.4.1)* *LO 1.2: Compare the results obtained and derive suitable conclusions (PI 2.1.3, PI 2.2.4, PI 8.2.1, PI 8.3.1).* *LO 1.3: Tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)* *LO 1.4: Simulate results for correlation with theoretical concepts (PI 5.1.1, PI 5.1.2)* *LO 1.5: Prepare a brief report based on the obtained results and conclusions (PI 9.1.1, PI 9.1.2)*	
02.	**Applications of Operational Amplifier** ***Learning Objectives:*** ***Design and implement the circuit based on various parameters its operation along with its output***	**04**
	Suggested Experiments: 1. Design of function generator using operational amplifier based differentiator. 2. Design of function generator using operational amplifier based integrator. 3. Design of a comparator using operational amplifier. 4. Design of Oscillator and switch debouncing using Schmitt trigger	
	Self-Learning Topics: ***Applications of Schmitt trigger.***	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Demonstrate various circuits related to applications of operational amplifier (PI: - PI 4.1.1, PI 4.2.1)* *LO 2.2: Compare the results obtained and derive suitable conclusions (PI 2.1.3, PI 2.2.4, PI 8.2.1, PI 8.3.1).* *LO 2.3: Tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)* *LO 2.4: Simulate results for correlation with theoretical concepts (PI 5.1.1, PI 5.1.2)* *LO 2.5: Prepare a brief report based on the obtained results and conclusions (PI 9.1.1, PI 9.1.2)*	
03.	**Filters, Waveform Generators, Oscillators & Precision rectifiers using operational amplifiers** ***Learning Objective:*** ***Design and implement the circuit based on various parameters its operation along with its output***	**06**
	Suggested Experiments: 1. Design Wein bridge and RC phase shift Oscillator for audio and radio frequency generation	

	2. Design and analyse Low pass, band pass and band reject filter for various applications 3. Design of a square wave generator 4. Design of a precision rectifier	
	Self-Learning Topics: ***Applications of Precision Rectifiers***	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Compare the results obtained and derive suitable conclusions (PI 2.1.3, PI: -2.2.4)* *LO 3.2: Tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)* *LO 3.3: Simulate results for correlation with theoretical concepts (PI 5.1.1, PI 5.1.2)*	
04.	**Timer IC 555 and its applications** ***Learning Objectives:*** ***1)Design the circuit based on various parameters*** ***2) Implement the circuits on breadboard and demonstrate its operation along with its output.*** ***3) Compare results and observation to derive suitable conclusion and relate it with theoretical concepts.***	**06**
	Suggested Experiments: 1. Blinking LED using Timer IC 555 2. Monostable multivibrators using Timer IC 555 3. Astable multivibrators using Timer IC 555 4. Pulse width modulation using IC 555.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 4.1: . Design various circuits related to applications of operational amplifier and timer IC 555 (PI 4.1.1, PI 4.2.1)* *LO 4.2: Compare the results obtained and derive suitable conclusions (PI 2.1.3, PI 2.2.4, PI 8.2.1, PI 8.3.1).* *LO 4.3: Tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)* *LO 4.4: Simulate results for correlation with theoretical concepts (PI 5.1.1, PI 5.1.2)* *LO 4.5: Prepare a brief report based on the obtained results and conclusions (PI 9.1.1, PI 9.1.2)*	
05.	**Voltage regulator integrated circuits** ***Learning Objective/s:*** ***Design and implement the circuit based on various parameters its operation along with its output.***	**04**
	Contents: Suggested Experiments: 1. Design regulated power supply using IC 723 2. Voltage regulation using IC LM317 3. Design of switched mode power supply.	
	Self-Learning Topics:	

	Learning Outcomes : *A learner will be able to* *LO 5.1: Comprehend the basics fundamentals of voltage regulation and its working (PI: 1.3.1, PI 1.4.1)* *LO 5.2: Compare the results obtained and derive suitable conclusions (PI 2.1.3, PI 2.2.4, PI 8.2.1, PI 8.3.1).* *LO 5.3: Implement the circuits using required components, and tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)* *LO 5.4: Correlate simulated results with theoretical concepts (PI 5.1.1, PI 5.1.2)* *LO 5.5: Prepare a brief report based on the obtained results and conclusions (PI 9.1.1, PI 9.1.2)*	
06.	**Special Purpose Integrated Circuits**	**04**
	Learning Objective/s: ***Design and implement the circuit based on various parameters its operation along with its output.***	
	Suggested Experiments: 1. Design frequency modulator using IC 566 2. Design of Modulator using IC 565	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Compare the results obtained and derive suitable conclusions. (PI 2.1.3, PI 2.2.4, PI 8.2.1, PI 8.3.1).* *LO 6.2: Tabulate the results and draw suitable graphs (PI 4.3.1, PI 4.3.3)*	
	Total	**30**
Minimum two experiments from modules 1 to 4, one experiment from modules 5 and 6, and total at least 10 experiments.		

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and accepted practice areas to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
4.1.1	Define a problem, its scope, and importance for purposes of investigation.
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures, test vectors.
4.3.1	Use appropriate procedures, tools, and techniques to conduct experiments and collect data
4.3.3	Represent data (in tabular and/or graphical forms) to facilitate analysis and explanation of the data, and drawing of conclusions.
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts

9.1.1 Read, understand and interpret technical and/or non-technical information.
9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation

Course Outcomes: A learner will be able to –

1. Realize various closed loop configurations of operational amplifier (*LO 1.1 to LO 1.5*)
2. Demonstrate various linear and non-linear applications of operational amplifier using hardware/suitable software tools. (*LO 2.1 to LO 2.5, LO 3.1 to LO 3.3*)
3. Design and implement circuits related to Timer IC555. (*LO 4.1 to LO 4.5*)
4. Demonstrate various special purpose integrated circuits. (*LO 5.1 to 5.5, LO 6.1, LO 6.2*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLBC403.1	3	3		3	3			3	3		
ECLBC403.2		3		3	3			3	3		
ECLBC403.3		3		3	3			3	3		
ECLBC403.4	3	3		3	3			3	3		
Average	3	3		3	3			3	3		

Text Books :

1. Operational amplifier and Linear Integrated Circuits, Ramakant A. Gayakwad, 4th Edition, Pearson Prentice Hall
2. Linear Integrated Circuits, D. Roy Choudhury and S. B. Jain, 4th Edition, New Age.International Publishers

Reference Books :

1. Integrated Circuits, K. R. Botkar, 2004, Khanna Publishers
2. Design with operational amplifiers and analog integrated circuits, sergio Franco, 3rd edition, Oxford University Press
3. Operation Amplifiers and Linear Integrated Circuits, David A. Bell, Indian Edition, , Oxford University Press Curriculum Structure and Syllabi (R-2024) – B. Tech. in Electronics & Telecommunication Engineering 245
4. Operation Amplifiers and Linear Integrated Circuits, R. F. Coughlin and F. F. Driscoll, 6th Edition, Prentice Hall.
5. Electronic Devices and Circuits, Millman, Christos CHalkias, and Satyabratatajit, , 3rd Edition, McGrawHill.

Other Resources :

1. NPTEL online course: Integrated Circuits, MOSFETs, OP-Amps, and their Applications: Web Link : https://archive.nptel.ac.in/courses/108/108/108108111/

IN-SEMESTER ASSESSMENT (25 MARKS)

A. CONTINUOUS ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task

assigned in the experiment description, record observation, interpret results/conclusion and prepare a brief report as per requirement.

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/Theoretical knowledge
- Practical knowledge
- Oral

• Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to perform the same. The students will be asked to write the theory related to the experiment. The write-up is checked by the examiners (Internal and External) and evaluated out of 05 Marks. Then the student will be allowed to perform the experiment.

• Students will be allocated 1 hour to perform the experiment. The results are then checked by both the examiners for its correctness. The weightage of the successful done experiment is 10 Marks

• Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC404	PRINCIPLES OF COMMUNICATION LAB	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total Marks**
25	25	50

Pre-requisite:

1. ESC203- Basic Electronics
2. ECPCC303- Electronics Circuits and Devices
3. ECPCC302- Network Theory

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 5: Engineering tool usage
6. PO 11: Life-long learning

Course Objectives:

1. To impart the conceptual knowledge on modulation and demodulation in time and Frequency domain.
2. To evaluate the performance parameters of receivers.
3. To develop the concept and need of pulse modulations.

Module	Details	Hrs.
	Course Introduction The Principles of Communication Engineering lab course provides a fundamental understanding of the principles, techniques, and technologies involved in communication systems. This lab course typically covers a wide range of topics related to the design, analysis, and implementation of communication systems used for transmitting and receiving information. It equips students with the knowledge and skills necessary to analyse, design, and optimize communication systems for various applications in industries such as telecommunications, broadcasting and networking.	**01**
01.	**Analog modulation and demodulation** ***Learning Objective:*** ***Analyze experimental results to validate theoretical concepts and understand practical implications to evaluate desired performance characteristics***	**08**

	Contents: Suggested list of experiments: 1. Design envelope detector for amplitude modulated (AM) signal and comment on the peak diagonal clipping. 2. Perform frequency modulation and demodulation and analyze the response based on different modulation indexes. 3. Design and implement Pre-emphasis and De-emphasis circuits for analog audio recording and playback systems. **4.** Analysis of aliasing effect on pulse amplitude modulated signals	
	Self-Learning Topics: ***Analysis of Analog communication systems.***	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to solve problems based on communication links. (P.I.-1.3.1)* *LO 1.2: Breakdown FM system into interconnected sub systems to analyze the demodulation of modulating signal at the receiver. (P.I.- 2.2.1)* *LO 1.3: Recognize the need of sampling theorem to reconstruct the original modulating signal. (P.I.- 3.1.1)* *LO 1.4: Define an unsampled pulse amplitude modulated signal and its scope to obtain an original signal from it. (P.I.- 4.1.1)* *LO 1.5: Apply concepts of modulation schemes to solve problems related to modulator circuits. (P.I.-1.4.1)* *LO 1.6: Identify relevant data from the given circuit and obtain an optimal design solution for generating an appropriate modulated frequency. (P.I.-3.3.3)* *LO 1.7: Identify existing process of modulation and demodulation to solve the problem of bandwidth to be utilized efficiently. (P.I.- 2.2.3)* *LO 1.8: Establish a relationship between variable frequency and fixed frequency signal to produce a modulated signal. (P.I.- 4.1.4)*	
02.	**Radio receivers and multiplexing in pulse modulated systems**	**08**
	Learning Objective: ***Analyze experimental results to validate theoretical concepts of multiplexing signals from different sources and understand practical implications to evaluate desired performance characteristics.***	
	Contents: **Suggested list of experiments:** 1. Comparison of ideal and practical characteristics of radio receivers. 2. Design a mixer circuit to generate the intermediate frequency for amplitude modulated broadcast receiver. 3. Analyze a Time Division Multiplexing (TDM)- Pulse Width Modulation (PWM) system for transmitting multiple analog signals over a single communication channel. 4. Design and implement a sample-and-hold circuit for analog signal sampling used in analog to digital converter (ADC).	
	Self-Learning Topics: ***Analysis of Analog pulse communication systems***	
	Learning Outcomes: *A learner will be able to*	

	LO 2.1: Apply fundamental engineering concepts to solve problems based on radio receivers. (P.I.-1.3.1) *LO 2.2: Breakdown pulse modulation system into interconnected sub systems to analyze the demodulation of modulating signal at the receiver. (P.I.- 2.2.1)* *LO 2.3: Recognize the effect of aliasing to reconstruct the original modulating signal. (P.I.- 3.1.1)* *LO 2.4: Define the scope of sample and hold circuit to obtain an original signal from it. (P.I.- 4.1.1)* *LO 2.5: Apply concepts of radio receiver characteristics to solve problems related to tuning circuits. (P.I.-1.4.1)* *LO 2.6: Identify relevant data from the given mixer circuit and obtain an optimal design solution for generating an appropriate intermediate frequency. (P.I.- 3.3.3)* *LO 2.7: Identify existing process of multiplexing to solve the problem of bandwidth to be utilized efficiently. (P.I.- 2.2.3)* *LO 2.8: Establish a relationship between variable frequency and fixed frequency signal to produce a time division multiplexed signal. (P.I.- 4.1.4)*	
03.	**Analysis of communication systems** ***Learning Objective:*** ***To Assemble and connect the components according to the transmitter-receiver architecture.***	**06**
	Contents: **Suggested list of experiments:** 1. Design and implement an amplitude modulation (AM) detector for receiving broadcasts in medium- wave (MW) band. 2. Investigation of signal to noise ratio for the given signal. 3. TV based experiment: to analyze the Vestigial sideband modulator of a TV.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Recognize the need of detector stage to extract the modulating audio signal from the output. (P.I.- 3.1.1)* *LO3.2: Use tools and techniques to analyze errors due to noise in communication systems. (P.I.- 5.1.2)* *LO3.3: Adapt to the current technologies based on the development of AM bands in the communication field. (P.I.- 11.2.2)* *LO3.4: Demonstrate proficiency in using tools to implement an AM based application. (P.I.- 5.2.2)* *LO3.5: Identify suitable criteria for TV signals and interpret the role of vestige. (P.I.- 3.2.3)* *LO 3.6: Source and comprehend technical literature based on the TV signals and relate to the practical examples. (P.I.- 11.3.1)*	
04.	**Application of Communication systems** ***Learning Objectives:*** ***To build a circuit according to the transmitter-receiver architecture according to the given specifications.***	**08**
	Contents: **Suggested list of experiments:** 1. Implement simple FM walkie talkie with the given data specification.	

	2. Design an FM Radio circuit that can be tuned to a required frequency. 3. Implement a synchronous clock generator using Phase locked loop (PLL) technique to generate pulse amplitude modulated (PAM) signal. 4. Implement and monitor the control of light intensity of LED's based on PWM technique.	
	Self-Learning Topics: ***TV signal transmission and reception***	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply fundamental engineering concepts to solve problems based on FM radio. (P.I.-1.3.1)* *LO 4.2: Apply concepts of phase locked loop to solve problems related to pulse amplitude modulated (PAM) signal. (P.I.-1.4.1)* *LO 4.3: Identify the need of detector stage to extract the modulating audio signal from the modulated output. (P.I.- 3.1.1)* *LO4.4: Use tools and techniques to analyze noise related errors in communication systems. (P.I.- 5.1.2)* *LO 4.5: Adapt to the current technologies based on the development of FM bands in the communication field. (P.I.- 11.2.2)* *LO 4.6: Demonstrate proficiency in using tools to implement an FM based application. (P.I.- 5.2.2)* *LO 4.7: Identify suitable criteria for PWM signals and interpret the role of duty cycle. (P.I.- 3.2.3)* *LO 4.8: Source and comprehend technical literature based on the FM Walkie-talkie and relate to the practical examples. (P.I.- 11.3.1)*	
	Total	**30**
Minimum two experiments from each module, and total at least 10 experiments.		

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.2.1	Breakdown complex problem into interconnected sub systems and analyse by proper assumptions/ justification from information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
3.1.1	Recognize that need analysis is key to good problem definition.
3.2.3	Identify suitable criteria for evaluation of alternate design solutions
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
4.1.1	Define a problem, its scope, and importance for purposes of investigation
4.1.4	Establish a relationship between measured data and underlying physical principles.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools.

11.2.2 Adapt to the current technologies regarding new developments in relevant field

11.3.1 Source and comprehend technical literature and other credible sources of information.

Course Outcomes: A learner will be able to -

1. Demonstrate modulation, demodulation, and multiplexing schemes. (*LO 1.1,1.5,1.6,1.7,1.8, LO 2.7,2.8, LO 3.3- LO 3.6, LO 4.5, LO 4.6, L O4.8*)
2. Analyse the characteristics of a radio receiver. (*LO 1.2, LO 2.2,2.5,2.6, LO3.1, LO 4.1, 4.3*)
3. Implement and analyse the pulse modulation circuits. (*LO 1.3, LO 1.4, LO 2.1, 2.3, LO 2.4, LO 4.2, LO 4.7)*
4. Evaluate the communication system for the noise parameters. *(LO 3.2, LO 4.4*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLBC404.1	3	3	3	3	3						3
ECLBC404.2	3	3	3								
ECLBC404.3	3		3	3							
ECLBC404.4					3						
Average	3	3	3	3	3						3

Text Books :

1. "Communication Systems", S. Haykin, 4th edition, 2001, John Wiley & Sons.
2. "Introduction to Analog and Digital Communications", S. Haykin and M. Moher, 2nd edition., 2007, Wiley.
3. "Modern Digital and Analog Communication Systems", B.P. Lathi, 3rd edition, 1998, Oxford University Press.

Reference Books :

1. "Communication Electronics", Louis Frenzel, 3rd Edition, Tata McGraw Hill.
2. "Electronic Communication Systems", Roy Blake, 2nd edition, Delmar publication.
3. Lab Manual:
   a. https://www.etti.unibw.de/labalive/manual/

   Experiment 3 and 8 of the manual can be referred to perform the experiment based on noise and multiplexing: ECC305 Communication System Lab.pdf (iitism.ac.in)

Other Resources :

1. NPTEL online course: Simulation of Communication Systems Using Matlab:
   Web Link: https://onlinecourses.nptel.ac.in/noc23_ee136/preview
2. Online course by NI (part of Emerson's group)
   Web Link: https://education.ni.com/teach/resources/16/introductory-communications-systems

A. CONTINUOUS ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observations, interpret results/conclusion and prepare a brief report as per requirement.

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Conceptual knowledge
- Practical knowledge
- Oral

- Students will be randomly allocated a problem statement from the list of laboratory exercises and will be asked to draw the circuit diagram / block diagram along with the expected results and observations. The written content is checked by the examiners (Internal and External) and evaluated out of 05 Marks.

Then the student will be allowed to start with the implementation of the experiment.

- Students will be allocated 1 hour to complete the execution. The output is then checked by both the examiners for its correctness. The weightage of the implementation is 10 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC405	Microcontroller and Embedded System Laboratory	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total Marks**
25	25	50

Pre-requisite:

1. ESL103: C programming Laboratory
2. ECPCC304: Digital Circuit Design
3. ESC204: Basic Electronics

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO 3: Design/Development of Solutions
3. PO 5: Engineering tool usage

Course Objectives:

1. To impart the fundamental concepts of microcontroller peripheral interfaces to solve complex problems.
2. To analyse and troubleshoot microcontroller-based systems efficiently.
3. To acquire proficiency in sensor and actuator interfacing with microcontrollers for diverse real-world applications, prioritizing safety and utilizing modern tools.

Module	Details	Hrs.
	Course Introduction This foundational course covers microcontroller peripheral interfaces, focusing on designing responsive systems, considering technical, economic, and societal factors, using modern tools and programming in embedded C and assembly. Its aim is to build abilities for both microcontroller–based system development and problem-solving opportunities in IoT, Embedded Systems, and various industries. Skills acquired enable contribution to innovative projects in automation, robotics, wearable technology, and adaptability for further education, entrepreneurship, or careers in technology.	**02**

01.

Microcontroller GPIO Programming

Learning Objective:

To equip students with the necessary skills to program microcontroller, to configure GPIO pins using IDE tools effectively.

Contents:

Suggested list of experiments:

1. Write a program to flash any port GPIO pin.
2. Two switches are connected to P0.1 and P0.2. Write a program to monitor the status of two switches and perform a task as mentioned in the following table.

P0.2	P0.1	Task
0	0	P3 = P2 ^ P1
0	1	Send the ASCII of A to P1
1	0	Read port P1 and send its complement on P3
1	1	P2.1 = 1, P2.2 =0

3. Develop an embedded C program incorporating an interrupt service routine (ISR) to control a staircase lamp using staircase switch.
4. Write a program to control sequence of an LEDs connected to GPIO using delays.
5. A Light Emitting Diode (LED) is connected to port pin P1.1 of the microcontroller. The task is to control the LED by turning it ON for 2 milliseconds and OFF for 3 milliseconds. This cycle repeats for 'n' iterations, where the value of 'n' is input through Port 2. Write an embedded C language program to perform this operation.
6. Design a microcontroller-based interrupt driven road traffic signaling system.
7. Design a microcontroller-based interrupt driven counter to count the number of bottles filled in one second and display it the output.

04

Self-Learning Topics:

Conduct a comparative analysis of latest IDE tools for microcontrollers.

Learning Outcomes:
A learner will be able to

LO 1.1: Demonstrate proficiency in analyzing various GPIO pins and its driving circuits, programming and debugging using an IDE tool (P.I.-5.2.2).

LO 1.2: Identify suitable I/O pins, interrupt driven approach for implementing a certain application (P.I.-3.1.6)

LO 1.3:Analyze the given I/O interfacing circuits and extract valid conclusions from the results. (P.I.- 2.4.4)

02.	**Microcontroller Peripheral Interface Programming**	**06**

Learning Objective:

Develop proficiency in designing and implementing microcontroller-based systems with diverse peripherals and effective peripheral interfacing and collaborative troubleshooting for various applications.

Contents: Suggested list of experiments:

1. The 8-bit ADC is used to measure temperature of a water heater. The output of ADC is connected to Port 1 of a microcontroller. Write a program to serially transmit the message "LOW TEMP" if the temperature falls below the defined threshold limit (assume 30H), and "HIGH TEMP" otherwise.
2. Implement a digital thermometer using ADC and display the temperature on an LCD
3. The 8-bit ADC is used to measure temperature of a water heater. The output of ADC is connected to Port 1 of a microcontroller. Write a program to display message " LOW TEMP" else " HIGH TEMP" on LCD, when the temperature falls below the defined threshold limit (assume 30H), and "HIGH TEMP" otherwise.
4. Design a system which contains a 4*4 key pad and 8 LEDs interfaced with a microcontroller. Develop a program to identify the pressed key and display the binary code of the pressed key on the connected LEDs
5. Implement a function generator using DAC to produce different types of waveforms.
6. Configure a microcontroller system equipped with multiple programmable I/O pins, including open-drain, internal passive pull-up, and tri-stated pins, to interface with various peripherals such as LEDs, keypads, ADCs, and DACs and perform the following task:
   The microcontroller is to be used in a system consisting of the following peripherals:
   (i) Two status indicator LEDs (L1, L2),
   (ii) 16 keys (K1, K2, ..., K16) capable of 0/1/2 key presses, and 3 keys (K17, K18, K19) allowing any combination of key presses,
   (iii) Two 8-bit ADCs (ADC1, ADC2), each with internal latch and 8-bit parallel tri-stated outputs, featuring two control inputs: Start and Output Enable,
   (iv) Two 6-bit DACs (DAC1, DAC2), each having internal latch and 6-bit parallel inputs, and a single control input: Latch Enable.
7. Design a microcontroller-based system to execute the following task: The two ADC's convert analog inputs simultaneously and periodically at a rate set by the internal programmable timer. The two DAC outputs are to require to produce data periodically but at different rates. Employ software debouncing for all keys within the system.

Self-Learning Topics:

Implement a decimal counter and display the count on seven segment display.

	Learning Outcomes: *A learner will be able to* *LO2.1: Accurately model complex interfacing circuits, including preprocessing and compatibility circuits, using IDE tools. (P.I.- 2.3.1)* *LO2.2: Demonstrate proficiency in understanding interfacing sequences, timing and the effects of various input conditions on system output. (P.I.- 2.4.4)* *LO2.3:Troubleshoot the interfacing devices, circuits, program and identify the sources of errors if any (P.I.-2.4.3)* *LO2.4:Select appropriate Peripheral devices based on the design requirements. (P.I.-3.1.6)* *LO2.5:Interface various peripherals devices with a selected microcontroller for a given application. (P.I.-3.2.2)*	
03.	**Microcontroller Programming with Sensors and Actuators** *Learning Objective:* *Acquire microcontroller programming skills for sensor and actuator interfacing, utilizing timer/PWM techniques to control electrical appliances and motors for real-world applications, including robotics.* **Contents:** **Suggested list of experiments:** 1. Write a program to control electrical appliances based on temperature using simple ON/OFF relay. 2. Write a program to generate a siren alarm after every t time. Siren need to be connected through relay for isolation. 3. Design a microcontroller-based system to regulate the speed of a DC motor using PWM method- a) manual mode b) based on temperature.(Temperature-Controlled Fan System) 4. A DC motor is used to operate a sliding gate and operated with the switch. Develop a C language program to control the operation of a sliding gate using a DC motor, which is interfaced with a microcontroller through an H-bridge (LD293). 5. A turn table is rotated manually by a foreman at desired angle. Design an automated control system using stepper/Servo motor interfaced with microcontroller. 6. Design and implement using microcontroller-based Fire-alarm system. 7. Design and Implementation of microcontroller-based Firefighting water extinguisher system with sensor-activated motor pump control. 8. Design and Implementation of a microcontroller-based water level control system with sensor-activated motor pump control. 9. Design a line-following robot using infrared sensors and motor control. 10. Design a microcontroller-based system for a. Smart Lighting System with Motion Detection b. Automated Plant Watering System c. Smart Door Lock System ***Self-Learning Topics:*** *Implementation of control algorithms (e.g. PID, fuzzy logic) in embedded systems.* ***Learning Outcomes:*** *A learner will be able to*	**6**

	LO 3.1: Visualize and process various sensors data and actuate the output devices for a specific real time application using appropriate tools. (P.I.-5.2.2) *LO 3.2: Design and implement microcontroller-based systems with sensors and actuators for a specified engineering application (P.I.-3.2.1)* *LO 3.3: Demonstrate the effective use of an IDE for programming a microcontroller and independently learn to develop microcontroller-based applications (P.I.-5.1.2),* *LO 3.4: Troubleshoot the circuit and identify the sources of errors if any (P.I.-2.4.3)* *LO 3.5: Determine design objectives, functional requirements and arrive at specifications ((P.I.-3.1.6)*	
4	**Microcontroller Interfacing using Communication Techniques**	**6**
	Learning Objectives: ***Develop proficiency in microcontroller-based communication protocols for controlling various peripherals and analyze/troubleshoot communication issues effectively.***	
	Contents: **Suggested list of experiments:** 1. Implement USART-based communication to display sensor data on a serial terminal. 2. Design UART-controlled DC motor system for speed and direction control, communicating with a PC. 3. Develop USART communication between microcontroller and LCD display for data transmission 4. Setup I2C communication for analog-to-digital conversion with microcontroller and ADC. 5. Setup SPI communication for digital-to-analog conversion between microcontroller and DAC.	
	Self-Learning Topics: ***Explore advanced communication protocols and comparison.***	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Select appropriate communication protocols based on the design requirements. (P.I.-3.1.6)* *LO 4.2: Demonstrate proficiency in understanding protocol timings, sequential flow for controlling peripheral devices and the effects of various handshaking signals on communication process (USART,I2C/SPI). to get desired output. (P.I.-2.4.4)* *LO 4.3: Troubleshoot the communication interfacing circuit, program, baud rate and identify the sources of errors if any (P.I.-2.4.3)* *LO 4.4: Use the modern simulation tools to implement communication protocols for a given task. (P.I.-5.1.2)*	
5	**Microcontroller Applications in Power Systems** ***Learning Objective/s:*** *To provide students with the essential skills and knowledge to proficiently use microcontroller-based systems for efficient power management using modern tools for analysis. By mastering power technology, they can implement precise control over*	**06**

	power requirements of machinery and excel in various industrial power automation and control environments. Suggested List of Experiments 1. Design a microcontroller-based system to regulate the brightness of an LED lamp using PWM signals. 2. Design ARM-based firing system for IGBT-triggered full-wave controlled rectifier. 3. Develop high-level language program to generate triggering pulses for chopper applications. 4. Develop high-level language program to use power savings features (Sleeping Modes)of microcontroller in Battery-Operated Microcontroller Systems. 5. Develop a microcontroller program to monitor and control the charging of a lithium-ion battery. 6. Design a microcontroller-controlled relay system to switch power sources based on predefined conditions (e.g., voltage thresholds, time schedules). 7. Develop a program to measure and display the real-time power consumption of electrical appliances using a microcontroller and energy metering IC. 8. Create a microcontroller-based system to detect and respond to overcurrent or short circuit faults in a power circuit. 9. Resource Utilization Assessment in Microcontroller-Driven Power Systems 10. Risk Analysis in designing microcontroller-based power systems. *Self-Learning Topics:* *Exploring emerging trends, safety, and regulations in microcontroller-driven power systems.* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1 : Gain an understanding of the integration of power devices with other automation technologies and systems, promoting interdisciplinary knowledge and collaboration in the field of industrial power systems. (P.I.-3.1.6)* *LO 5.2 : Create and troubleshoot power control circuity and programs for implementing real world societal / industrial problems/ application using microcontroller-based power systems, understand input/output demands, configurations, implement control strategies (P.I.- 3.2.2)* *LO 5.3 : Select open-source Simulation tools for power system-based applications. (P.I.- 5.1.2)* *LO 5.4 : Develop problem-solving skills to troubleshoot microcontroller-driven power systems., fostering their adaptability in real-world industrial environments (P.I.-5.2.2)*	
	Total	***30***
Minimum two experiments from each module, and total at least 10 experiments.		

Performance Indicators:

P.I. No.	P.I. Statement
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.1	Apply mathematical techniques and formal design principles to generate multiple engineering solutions for complex problems, incorporating higher-order thinking skills
3.2.2	Build models/prototypes to develop diverse set of design solutions
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools.

Course Outcomes: A learner will be able to -

1. Develop proficiency in using GPIO pins of microcontrollers and IDE tools for solving given tasks. (*LO 1.1,LO 1.2 ,LO 1.3*)
2. Apply microcontroller interfacing and programming skills for various peripherals to solve engineering problems with societal and environmental considerations. (*LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)*
3. Develop proficiency in sensor and actuator interfacing with microcontrollers, prioritizing safety and utilizing modern tools. (*LO3.1, LO3.2, LO3.3, LO3.4, LO3.5)*
4. Design, implement, and evaluate microcontroller-based power management system. *(LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLC405.1		2	2		2						
ECLC405.2		3	3								
ECLC405.3		2	3		3						
ECLC405.4		3	3		3						
Average		3	3		3						

Reference Books :

1. "Microcontroller Theory and Applications with the PIC18F" by M. Rafiquzzaman, 1st Edition, 2011, Wiley
2. “Embedded Systems: Architecture, Programming, and Design”, Raj Kamal, 3rd Edition, 2017, McGraw-Hill Education.

Other Resources :

1. NPTEL Course: Introduction to Embedded System Design, by Prof. Dhananjay V. Gadre, Prof. Badri Subudhi, Netaji Subhas University of Technology, IIT Jammu.

Web link- https://onlinecourses.nptel.ac.in/noc24_cs33/preview

2. NPTEL Course: Embedded Systems, by Prof. Santanu Chaudhary Prof. Santanu Chaudhary, Department of Electrical Engineering, IIT Delhi
   Web link-https://nptel.ac.in/courses/108102045
3. Forums and communities. (Microchip Forum, STM32 Community)
4. ARM Architecture Reference Manuals, Keil Development tools - ARM Documentation

A. CONTINUOUS ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observations, interpret results/conclusion and prepare a brief report as per requirement.

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2/ Course Project– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/Theoretical knowledge
- Practical knowledge
- Oral

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to perform the same. The students will be asked to write the theory related to the experiment. The write-up is checked by the examiners (Internal and External) and evaluated out of 05 Marks.

  Then the student will be allowed to perform the experiment.

- Students will be allocated 1 hour to perform the experiment. The results are then checked by both the examiners for its correctness. The weightage of the successful done experiment is 10 Marks
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
SBL	ECSBL402	SIMULATION LAB	02

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
50	50	100

Pre-requisite:

1. ESCLC203- Basic Electronics Engineering
2. ESL206- Basic Electronics Engineering Laboratory
3. ECPCC303- Electronics Devices and Circuits
4. ECPCC304 - Digital Circuit Design
5. ECLBC302 Digital Circuit Design Laboratory

Program Outcomes addressed:

1. PO 2: Problem analysis
2. PO 3: Design/Development of Solutions
3. PO 5: Engineering tool usage
4. PO 12: Life-long learning

Course Objectives:

1. To familiarize students with Simulation software for building and analysing electronic and pulsed circuits.
2. To provide practical exposure to concepts of transient and frequency systems for open loop and closed loop systems.
3. To introduce ladder diagram programming for PLC simulation and provide students with hands-on experience in designing ladder logic circuits.

Module	Details	Hrs.
	Course Introduction The Simulation Lab provides a platform for students to bridge theory with practical application, promoting hands-on experience. Simulation helps in enhancing understanding of complex electronic concepts through virtual experimentation.	**01**
01.	***Electronic Circuits using Suitable Simulation tool*** ***Learning Objective:*** *To develop deeper understanding of electronic circuits and their applications, improve their problem-solving abilities, and gain hands-on experience in working with various electronic devices and circuits.*	**15**

	Content: Use of simulation tools to perform experiments based on analog electronics. **Suggested List of Experiments** 1. Motor direction Control using H-Bridge 2. Trouble shooting 3. Transient Analysis of RL and RC circuits 4. Function generators using IC 555 and IC 741. 5. Electronic Stop Watch / Digital Clock 6. Data logger 7. Analog IC Tester 8. Amplitude modulator and Demodulator 9. Pattern generators using LEDS 10. DC-DC convertors	
	Self-Learning Topics: --	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Analyse the given electronic circuit and extract valid conclusions from the results. (2.4.4)* *LO 1.2 Troubleshoot the circuit and Identify the sources of errors if any (2.4.3)* *LO1.3 Design and implement electronics circuits for a specified engineering application (3.2.1)* *LO 14 Use the modern simulation tools to implement an electronic circuit for a given task. (5.1.2)* *LO 15:Demonstrate proficiency in analyzing various electronic circuits and devices using a modern simulation tool (5.2.2).*	
02.	**Pulsed Circuits**	**16**
	Learning Objective: *To design pulsed circuits which form an integral part of modern automated systems and explore the capabilities of simulation software to build and analyze prototypes of such systems*	
	Contents: Use of simulation tools to perform experiments based on digital electronics. **Suggested List of Experiments** 1. Simulation of ADC 2. Simulation of DAC 3. Electronic Password Lock for Appliances 4. Mixing of Audio signals using Mux 5. Digital IC tester 6. Multi Status Indicator	

	7. Memory address decoding / chip selection in 8086.	
	Self-Learning Topics: --	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Accurately model complex digital circuits, including combinational and sequential logic elements, using simulation software. (2.3.1)* *LO 2.2: Demonstrate proficiency in understanding circuit timing, propagation delays, and the effects of various inputs on circuit output. (2.4.4)* *LO 2.3: Troubleshoot the circuit and Identify the sources of errors if any (2.4.3)* *LO 2.4: Select appropriate components and digital ICs based on the design requirements. (3.1.6)* *LO 2.5: Design and implement digital circuits for a specified engineering application (3.2.2)* *LO 2.6: Use the modern simulation tools to implement a digital circuit for a given task. (5.1.2)* *LO 2.7: Demonstrate proficiency in analyzing various digital circuits and devices using a modern simulation tool (5.2.2)*	
03.	**Control System Analysis**	**16**
	Learning Objective: *To equip students with the necessary skills to analyze open loop and closed loop control system.*	
	Contents: Introduction to Control systems, steady state response and frequency response. Time and Frequency domain analysis of control systems and process controllers. **Suggested List of Experiments** 1. Transient and steady state response of first and second order control systems 2. Frequency domain analysis of second order system using bode plot, root locus 3. Effect of P, PD, PI, PID controller on a second order system 4. Temperature controller using PID controller	
	Self-Learning Topics: *Stability analysis using Nyquist Plot*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Model the given control system and analyze its response for any arbitrary input. (2.4.4)* *LO 3.2: Evaluate the frequency domain behavior of the given control system through skillful use of contemporary engineering techniques.(2.4.2)* *LO 3.3: Demonstrate the effective use of a simulation software for analyzing the given control system and Independently learn to develop and troubleshoot various process controller based applications (5.1.2), (11.1.3)* *LO 3.4: Visualize and interpret the effect of process controllers for a specific real time application. (5.2.2)*	

04.	PLC Simulators using Online Simulators ***Learning Objectives:*** *To provide students with the essential skills and knowledge to proficiently utilize Programmable Logic Controllers (PLCs) in modern industrial automation settings.* *To implement precise control over machinery and excel in various industrial automation and control environments.*	**12**
	Contents: Concept of PLCs, Ladder diagrams, Use of simulation tools to perform ladder diagram based experiments for PLC. **Suggested List of Experiments** 1. Water Tank Level Control: A ladder diagram to control the level of water in a tank using level sensors, motorized valves, and alarms. 2. Temperature Control: A ladder diagram to control the temperature of a room using a temperature sensor, heater, and fan. 3. Pump Control: A ladder diagram to control the operation of a pump based on the level of a liquid in a tank using level sensors and pump control relays. 4. Sequential Process Control: Bottle filling station 5. Elevator Control: A ladder diagram to control the operation of an elevator system with floor selection buttons, door control, and safety mechanisms. 6. Batch Mixing Control: A ladder diagram to control the mixing process of different ingredients in a batch using timers, valves, and pumps. 7. Vending Machine Control: A ladder diagram to control the operation of a vending machine, including coin input, product selection, and dispensing. 8. PLC based Automatic Packaging System	
	Self-Learning Topics: Ladder diagrams of advanced industrial systems	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Gain an understanding of the integration of PLCs with other automation technologies and systems, promoting interdisciplinary knowledge and collaboration in the field of industrial automation. (3.1.6)* *LO 4.2: Create and troubleshoot ladder logic programs for implementing real world societal / industrial problems/ application using PLC based systems, understand input/output configurations, implement control strategies (3.2.2), (6.1.1)* *LO 4.3: Use open source Simulation tools for PLC based applications. (5.1.2)* *LO 4.4: Develop problem-solving skills to troubleshoot PLC-based systems, fostering their adaptability in real-world industrial environments (5.2.2).*	
	Course Conclusion	**01**
	Total	**60**
Minimum 02 experiments from Module nos 1, 2, and 4; 03 experiments from module 3; total at least 09 experiments.		

Performance Indicators:

P.I. No.	**P.I. Statement**
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications

3.2.1 Apply mathematical techniques and formal design principles to generate multiple engineering solutions for complex problems, incorporating higher-order thinking skills
3.2.2 Build models/prototypes to develop diverse set of design solutions
5.1.2 Use/adapt/modify/create tools and techniques to solve engineering problems
5.2.2 Demonstrate proficiency in using discipline-specific tools.
6.1.1 Identify social, environmental and health related issues with the help of relevant viewpoints from stakeholders and propose engineering solutions.
11.1.3 Develop ability to learn independently through methods distinct from instructor-provided materials.

Course Outcomes: A learner will be able to -

1. Design and analyse electronic circuits and develop proficiency in using simulation software for testing and troubleshooting the circuits. *(LO 1.1 to LO 1.5)*
2. Design and simulate complex digital circuits for the given application using modern tools while selecting appropriate components to meet engineering requirements. *(LO 2.1 to LO 2.7)*
3. Investigate the behaviour of a given control system in time and frequency domains using simulation tools. *(LO 3.1 to LO 3.4)*
4. Identify components of a PLC based automation systems for real-world industrial applications and simulate the system by writing ladder diagrams for the same. *(LO 4.1 to LO 4.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECSBL402.1		3	2		3						
ECSBL402.2		3	3		3						
ECSBL402.3		3			3						2
ECSBL402.4			3		3	2					
Average		3	3		3	2					2

Text Books :

1. Multisim for Circuit Analysis, Electronics, and Power Electronics by James M. Fiore.
2. Multisim Simulation and Circuit Analysis: A Beginner's Guide by Amarpreet Singh and Raj Kumar Bansal.
3. Modern Control Engineering, Ogata K, Yang Y., 3rd Edition, 2002 Prentice hall.
4. Control System Engineering, Nagrath, M.Gopal , 7th Edition, 2021, New Age International Private Limited.
5. Industrial automation: hands-on, Lamb, Frank, 2013, McGraw-Hill Education.

Reference Books :

1. Circuit analysis with Multisim, Báez-López, David, and Felix Guerrero-Castro, 2nd Edition, 2022, Springer Nature.
2. Feedback Control of Dynamic Systems, Gene Franklin, J. Da Powell, and Abbas Emami-Naeini
3. Dynamic System Modeling and Control with MATLAB and Simulink, Joaquin C. Garcia-Sanchez and Agustin F. Schaffer
4. Programmable Logic Controllers: Industrial Control, Khaled Kamel and Eman Kamel , 1st Edition, 2013, Tata McGraw Hill Publishing Co. Ltd.

Other Resources :

1. Guide to mastering PLC
   https://sites.google.com/uah.edu/openplctipsandtricks/openplc

A. IN-SEMESTER ASSESSMENT (50 marks)

1. Continuous assessment of Experiments (30 Marks)

Suggested breakup of distribution

Students will be assigned experiments from the list given in syllabus. They have to perform the laboratory tasks, and get the desired output.

Students will be evaluated based on following:

i. Design – 10 Marks
ii. Execution of Simulation - 10 Marks
iii. Interpretation of results - 5 Marks
iv. Troubleshooting - 5 Marks

2. Practical Test (15 Marks)

Practical examination on first 50% of the practical list will be conducted for one-and-a-half-hour.

Students will be randomly allocated a task from the list of laboratory exercises. Evaluation will be done by Internal Examiner as follows:

Design: 5 marks

Simulation execution and presentation of results and their interpretation: 5 marks

Oral Examination: 5 marks

3. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (50 Marks)

Students will be assessed based on three parameters:

- Selection of appropriate Simulation tool
- Design of circuit / Algorithm / Ladder diagram
- Simulation of the circuit and Analysis of the results
- Oral

Students will be randomly allocated a task for designing and implementing Electronic/ Digital/ Controller based / PLC based system for the given application and implement using an appropriate simulation tool from the list of laboratory exercises and will be asked to design the circuit / Algorithm / Ladder diagram. The circuit / Algorithm / Ladder diagram is checked by the examiners (Internal and External) and evaluated out of 10 Marks.

- Students will be allocated 1 and half hour to complete the execution. The program is then checked by both the examiners for its correctness. The weightage of the program implementation is 20 Marks
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 20 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
MP	ECMNP402	Mini Project 1B	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total**
50	50	100

Pre-requisite:

1. ECMP301- Mini Project 1A

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer & World
7. PO7: Ethics
8. PO8: Individual & Collaborative teamwork
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To familiarize students about available infrastructure at Department/Institute level, online resources, plagiarism, expectations from MP 1B.
2. To guide students in identifying societal or research needs and formulating them into problem statements.
3. To facilitate problem-solving in group settings.
4. To apply basic engineering principles to address identified problems.
5. To foster self-learning and research skills.

Guidelines for the Mini Project

1. At the beginning of semester-III, project guides are required to conduct around 4 hours' orientation sessions including following topics:

- Familiarizing students about infrastructure available at Department/Institute level and how to use it.
- How to identify societal problems and formulate project problem statement.
- How to carry out literature survey.
- What is plagiarism and what care needs to be taken while writing a report.
- What is project report template and how it should be used.
- What are expectations from mini-projects 1B.

2. Mini project may be carried out in one or more form of following:
Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

3. Students must form groups of 3 to 4 members either from the same or from different departments.

4. Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.

5. An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.

6. Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.

7. Faculty input should emphasize guiding by faculty and self-learning by group members.

8. Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.

9. The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Research papers, competition certificates may be submitted as part of annexure to the report.

10. With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.

11. However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Course Outcomes:
Students will be able to –

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
    - Research/white paper/article/blog writing/publication, etc.
    - Business plan for entrepreneurship product creation
    - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester IV (50 marks):
    - 20 marks for the In-Semester Two Presentations
    - 05 marks for Participation in Project Competitions, TPP, etc.
    - 20 marks for the Final Report & Presentation
    - 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester IV:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
    - The first review will assess the readiness to build a working prototype.
    - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

End-Semester Examination in Semester IV (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
VEC	VEC402	ENVIRONMENT & SUSTAINABILITY	02

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO6: The Engineer & The World
3. PO7: Ethics
4. PO11: Life-long learning

Course Objectives :

1. To provide students with foundational knowledge and understanding of environmental science principles and concepts.
2. To explore the principles of sustainability and their applications in various domains of engineering and technology.
3. To familiarize students with the legal and ethical considerations associated with environmental management and sustainability practices.
4. To equip students with practical skills and strategies for promoting renewable energy, energy efficiency, waste management, and environmental impact assessment.

Module	Details
01.	**Foundations of Environmental Sciences** Introduction to Environmental Science, Earth's Systems: Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecological Principles: Energy flow, Nutrient cycling, Biodiversity, Environmental Degradation: Pollution, Deforestation, Habitat loss, Environmental Monitoring and Data Analysis.
02.	**Sustainability Basics** Concepts of Sustainability and Sustainable Development, Sustainable Resource Management: Water, Air, Land, Sustainable Agriculture and Food Systems, Sustainable Transportation and Urban Planning, Sustainable Business Practices and Corporate Social Responsibility
03.	**Legal & Ethical Considerations** Environmental Laws and Regulations: National and International Perspectives, Environmental Policies and Governance Frameworks, Ethical Issues in Environmental Decision Making, Environmental Justice and Equity, Corporate Ethics and Environmental Responsibility
04.	**Renewable energy & Energy efficiency** Introduction to Renewable Energy Sources: Solar, Wind, Hydro, Biomass, Geothermal, Energy Conversion Technologies and Systems Energy Efficiency Measures and Strategies, Policy Support for Renewable Energy Deployment, Economic and Environmental Impacts of Renewable Energy
05.	**Waste management & recycling** Solid Waste Management: Collection, Treatment, Disposal, Recycling Processes and Technologies, E-waste Management and Hazardous Waste Handling, Circular Economy Principles, Waste Reduction Strategies: Source Reduction, Reuse, Repair

06.	**Environmental Impact Assessment** Introduction to Environmental Impact Assessment (EIA), EIA Process: Screening, Scoping, Impact Assessment, Mitigation, Monitoring, Methods and Tools for Impact Assessment: GIS, LCA, Risk Assessment, Case Studies of EIA in Various Sectors: Infrastructure, Energy, Mining, Construction, Role of Stakeholders in EIA Process
Total no. of hours: **30**	

Course Outcomes:

1. Gain a comprehensive understanding of key environmental science principles and their relevance to engineering disciplines.
2. Apply principles of sustainability to analyse and address environmental challenges in engineering projects and processes.
3. Demonstrate awareness of legal and ethical considerations in environmental decision-making and management practices.
4. Develop proficiency in implementing renewable energy technologies and energy-efficient practices in engineering designs and operations.
5. Acquire knowledge and skills in waste management, recycling, and circular economy principles for sustainable resource utilization.
6. Apply environmental impact assessment methods to evaluate and mitigate the environmental impacts of engineering projects and activities.

Text Books :

1. Environmental Science: Toward a Sustainable Future by Richard T. Wright and Dorothy F. Boorse (Publisher: Pearson Education)
2. Introduction to Environmental Engineering and Science by Gilbert M. Masters and Wendell P. Ela (Publisher: Pearson Education)
3. Renewable and Efficient Electric Power Systems by Gilbert M. Masters (Publisher: Wiley)

Reference Books:

1. Environmental Law Handbook by Thomas F. P. Sullivan, David R. Buente Jr., and Sally Fairfax, Bernan Press
2. Sustainability Science by Bert J. M. de Vries, Springer
3. Environmental Impact Assessment: Theory and Practice by Peter Wathern, Routledge

Other Resources:

1. NPTEL Course: Introduction to Environmetal Engineering & Science- Fundamental & Sustainability Concepts, Prof.Brajesh Kumar Dubey, Department of Multidisciplinary IIT Kharagpur :-Web link https://archive.nptel.ac.in/courses/127/105/127105018/
2. NPTEL Course: Environment And Development, By Prof. Ngamjahao Kipgen, IIT Guwahati, Web link- https://onlinecourses.nptel.ac.in/noc23_hs133/preview

H. Third Year Syllabi

Course Type	Course Code	Course Name	Credits
PCC	ECPCC509	SIGNALS AND SYSTEMS	03

Examination Scheme					
Distribution of Marks			**Exam Duration (Hrs.)**		**Total Marks**
In-semester Assessment		**End Semester Examination (ESE)**			
Continuous Assessment	**Mid-Semester Exam (MSE)**		**MSE**	**ESE**	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC405 Engineering Mathematics-IV

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO6: The Engineer & Society
5. PO8: pIndividual & team work

Course Objectives:

1. To introduce the concept of sampling for band limited signals.
2. To familiarise the students with discrete time signals, their representation, types and operation on them.
3. To impart knowledge of types of discrete time systems and explain the concept of convolution in context of Linear Time Invariant systems and their interconnections.
4. To teach the principles of auto-correlation, cross-correlation, their analogy with convolution, and to explain energy spectral density (ESD), power spectral density (PSD), and their relationships with auto-correlation.
5. To equip students with the ability to apply the z-Transform and its inverse in analysing discrete-time signals and systems, understand system stability and causality.
6. To guide students to analyse discrete-time signals and systems using Fourier Transform, understand its properties and limitations and evaluate system responses to aperiodic signals and white noise.
7. To educate the students about the contribution of poles and zeros in the computation of magnitude and phase response of a given system and guide them in understanding their significance while designing frequency selective filters.

Module	Details	Hrs.
	Course Introduction Overview of Continuous time signals, Real time signals such as communication, satellite, biomedical etc., Single dimension and multidimensional signals, Open and closed loop systems in real time, Need of representation of data in mathematical form and processing them with the help of systems.	**01**
01.	**Introduction to Discrete Time signals** ***Learning Objective:*** *1. To introduce sampling theorem for band limited signals* *2. To educate the students about types of discrete time signals and various operations on them*	**7-8**
	Contents: Revision of Continuous time Signals and Sampling theorem* Sampling Theorem: Sampling of band limited signals Representation of DT Signals: Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp. Operations on signals: Amplitude Scaling, Time Shifting, Reversal, Time Scaling, Addition, Subtraction, Multiple operation on single signal Classification of signals: Even and odd signals, periodic and nonperiodic signals, deterministic and non-deterministic signals, energy and power signals.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply mathematical techniques represent classify discrete time signals and formulate complex signals using elementary signals (PI 1.1.3)(PI 2.1.3)* *LO 1.2: Apply fundamental engineering concepts to sample band limited signals and analyse aliasing errors (PI 1.3.1) (PI 2.4.3)*	
02.	**Time domain analysis of Discrete Time systems** ***Learning Objective:*** *To introduce the concept of convolution for obtaining the output of an LTI system and their interconnections*	**7-8**
	Contents: Revision of Continuous time Systems and Convolution integral* Systems and Classification of systems: System Representation, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system. Linear Time Invariant (LTI) systems: Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	

	Use of convolution sum for analysis of LTI systems, properties of convolution sum, impulse response of interconnected systems.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental transforms to analyse continuous time signals in the Laplace domain (PI 1.1.2)* *LO 2.1: Apply the concept of convolution to determine the response of an LTI systems and analyse its behavior. (PI 2.4.1.)(PI 1.4.1)* *LO 2.2: Test the given system for stability and causality based on the impulse response and system equation. (PI 2.4.4)*	
03.	**Correlation and Spectral Density** ***Learning Objective:*** 1. *To educate the students about the use of correlation for finding similarity in signals.* 2. *To explain the significance of Spectral density for Energy and Power signals*	**4-5**
	Contents: Auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Use contemporary engineering techniques such as Autocorrelation to gain insight into the Spectral Density of real time discrete time signal (PI 2.4.2), (PI 6.1.1)* *LO 3.2: Apply engineering mathematics to obtain the similarity between two signals using cross correlation (PI 1.4.1)* *LO 3.3: Analyze the characteristics of random signals using autocorrelation (PI 2.1.3)*	
04.	**z-Transform and Discrete time LTI systems** ***Learning Objectives:*** 1. *To educate the students about Mapping between S-domain and z-domain along with the Concepts Region of Convergence* 2. *To guide the students to perform mathematical analysis discrete time systems using z- transform*	**7-8**
	Contents: z-Transform: Need of z-Transform, z-Transform of finite and infinite duration sequences, Concept of Region of Convergence, z-Transform properties, Standard z-transform pairs, relation between z-Transform and discrete time Fourier Transform, one sided z-Transform. Inverse z-Transform: Partial Fraction method only. Analysis of discrete time LTI systems using z-Transform: Systems characterized by Linear constant coefficient difference equation,	

	Transfer Function, plotting Poles and Zeros of a transfer function, causality and stability of systems, Total response of a system.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Compute the z- transform of a given discrete time function and estimate its ROC (PI 1.1.2)* *LO 4.2: Apply the properties of z- transform to compute the z-transform of discrete time signals (PI 1.3.1)* *LO 4.3: Identify appropriate impulse responses for stability and causality in the z-domain (PI 2.1.2)* *LO 4.4: Analyse a given system collaboratively by identifying mathematical assumptions necessary to allow modelling of a discrete time system for satisfying the given criteria. (PI 2.3.2)(PI 8.3.1)*	
05.	**Discrete-Time Fourier Transform** *Learning Objective/s:* 1. *To educate the students about use of the limited form of Z transform for spectral analysis of Discrete time signals and systems.* 2. *To guide students in carrying out frequency domain analysis of discrete time signals and systems using Discrete Time Signal Processing.*	**6-7**
	Contents: Fourier transform of non-periodic functions, Properties of Fourier Transform, Relation between DTFT and Z transform: Limitations of Fourier Transform, Inverse Fourier Transform, Analysis of LTI Discrete Time System Using Discrete Time Fourier Transform, Response to Aperiodic Input Signals, Response to white noise.	
	Self-Learning Topics: *Fourier transforms of Periodic function*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply mathematical transforms to obtain the frequency domain representations of discrete time non periodic functions. (PI 1.1.2)* *LO 5.2: Apply Dirichlet's conditions and the Gibbs Phenomenon (PI 1.4.1)* *LO 5.3: Analyse the discrete time systems in frequency domain using Fourier transform (PI 2.4.1)* *LO 5.4: Use DTFT properties to collaboratively comprehend the frequency domain behaviour of discrete real time time signals and systems (PI 2.1.2)(PI 8.3.1)(PI 6.1.1)*	
06.	**LTI systems as frequency-selective filters** ***Learning Objective/s:*** 1. ***To introduce the geometrical method of computation of magnitude and phase response.***	**6-7**

	2. *To guide the students in designing frequency selective filters using Pole zero placement.* 3. *To introduce the significance of Minimum phase and Maximum Phase systems.*	
	Contents: Geometric method of computation of Magnitude and Phase Response, Transfer function of low pass, high pass, notch, comb, all-pass filters, and digital resonators (using Pole - Zero placement), Minimum Phase and Maximum Phase Systems.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply engineering mathematics and computations to analyse Discrete time systems in the transform domain (PI 2.4.1)* *LO 6.2: Obtain the transfer function for a given frequency selective response using pole zero placement (PI 2.4.2)(PI 3.3.3)*	
	Course Conclusion	**01**
	Total	**45**

* No questions should be asked on these topics during the evaluation

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.2	Apply mathematical transforms to solve problems
1.1.3	Apply advanced mathematical techniques of computer and information science to describe/solve/construct a mathematical model of a system.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1.	Apply concepts of electronics and communication engineering and accepted practice areas to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4.	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.

3.3.3 Identify relevant data from the given resources and arrive at a best fitting design solution for particular specifications.

6.1.1 Identify social, environmental and health related issues with the help of relevant viewpoints from stakeholders and propose engineering solutions.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

Course Outcomes: A learner will be able to -

1. Classify and perform time domain operations on different types of discrete time signals.
2. Classify discrete time systems and perform time domain analysis of Linear Time Invariant systems.
3. Analyse discrete time LTI signals and systems in transform domain for stability and causality.
4. Analyse signals and systems in the frequency domain using Fourier Transform, including the concepts of Correlation and Power Spectral Density.
5. Design and analyse Frequency selective filters using pole zero plots.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECPCC509.1	3	3										
ECPCC509.2	3	3										
ECPCC509.3	3	3						2				
ECPCC509.4	3	3				2		2				
ECPCC509.5	3		2									
Average	3	3	2			2		2				

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books :

1. Nagoor Kani, “Signals and Systems”, Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, “Principles of Linear Systems and Signals”, Oxford, Second Edition, 2010.
3. S. L. Nalbalwar, A. M. Kulkarni and S. P. Sheth, “Signals and Systems”, Synergy Knowledgeware, 2016.
4. Proakis JG, Manolakis DG. “Digital Signal Processing–Principles, Algorithms Applications”, Pearson Education, Prentice Hall, 4th Edition, 2007.

Reference Books :

1. Simon Haykin and Barry Van Veen, “Signals and Systems”, John Wiley and Sons, Second Edition,2004.

2. Hwei. P Hsu, “Signals and Systems”, Tata McGraw Hill, Third edition, 2010
3. V. Krishnaveni and A. Rajeshwari, “Signals and Systems”, Wiley-India, First Edition 2012.
4. NarayanaIyer, “Signals and Systems”, Cenage Learning, First Edition 2011.
5. Michael J Roberts, “Fundamentals of Signals and systems”, Tata McGraw Hill, special Indian Economy edition, 2009.
6. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, “Signals and Systems”, Pearson Education, Fourth Edition 2009.
7. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”, Prentice-Hall of India, Second Edition, 2002

Other Resources :

1. Dr. K.N. Hari Bhat, Digital Communication, 2nd ED. Pearson Education.
2. Sanjay Sharma, Signals and Systems, With MATLAB, Katson Books
3. Charles Phillips, John Parr, Eve Riskin, Signals, systems and Transforms, Pearson.
4. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/studymaterials

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

a) MCQ test strictly as per GATE exam pattern / level): 05 Marks
b) Class test: 05 Marks
c) Design Assignment: 05 Marks OR Think Pair share Design activity: 05 Marks
d) Regularity and active participation: 05 Marks

2.Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPCC510	Digital Communication	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC304 Digital circuit design
2. ECPCC405 Engineering Mathematics-IV
3. ECPCC406 Linear Integrated circuits
4. ECPCC407 Principles of Communication

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 6: The Engineer and The World
6. PO 11: Life-long learning

Course Objectives:

1. To familiarize the basics of information theory and source coding.
2. To exhibit various error control codes
3. To acquaint different digital modulation and demodulation techniques
4. To describe baseband system and its application

Module	Details	Hrs.
	Course Introduction This course is designed to introduce the fundamental concepts and techniques used in the transmission of information in digital form. As digital systems dominate today's communication landscape—from mobile phones to satellite systems—the knowledge gained here will help students to understand how these technologies work and enable them to apply that knowledge in real-world scenarios.	**01**
01.	**Information Theory and Source Codes** ***Learning Objective:*** • ***To introduce source coding techniques.***	**05**

	• ***To facilitate understanding of information theory in Digital Communication Systems.***	
	Contents: Block diagram of digital communication system, Information content of a source symbol, Source entropy, mutual entropy, Average information rate, AWGN channel, and Shannon Hartley channel capacity theorem. Introduction of source code, Huffman code, Shannon-Fano code, Lempel Ziv coding	
	Self-Learning Topics: ***Prefix codes***	
	Learning Outcomes: *A learner will be able to* *LO 1.1 Apply concepts of source entropy and average information rate to evaluate the efficiency of a communication system. (P.I.-1.4.1)* *LO 1.2 Apply the fundamental concept of information theory to understand the importance of its characteristics in digital communication systems. (P.I.- 1.3.1)* *LO1.3 Produce and validate results of source coding techniques to generate code bits with high performance parameters through use of contemporary techniques. (P.I. 2.3.1)* *LO1.4 Extract desired understanding of source coding techniques such as Huffman, Shannon Fano codes and draw conclusions based on the objectives and limitations to generate highly efficient code bit (PI: 2.4.4)*	
02.	**Channel Coding Techniques** ***Learning Objective:*** • ***To help learners understand the fundamentals of channel encoding and its performance metrics to analyze linear block codes and cyclic code.*** • ***To develop learner's understanding on convolutional codes using state diagrams, code trees, and trellis diagrams for efficient error correction.***	**12**
	Contents: Need for channel encoding, redundancy, code rate, code efficiency and hamming bound. Linear block codes, cyclic codes. Convolution codes: State diagram, code tree, trellis diagram. Decoding of Convolutional codes using Viterbi algorithm. Application of channel coding techniques.	
	Self-Learning Topics: ***Turbo codes***	
	Learning Outcomes: *A learner will be able to* *LO 2.1 Apply the concept of error detection and error correction capability to understand the importance of its characteristics in digital communication systems. (P.I.- 1.3.1)* *LO 2.2 Determine design objectives and need of generator matrix for a given (n, k) system to reach a certain criteria based on hamming distance (P.I-.3.1.6)* *LO 2.3 Identify relevant code word for a given input message and attain an efficient channel coding design approach based on error correcting capability. (P.I. –3.3.3)* *LO 2.4 Produce and validate numerical results related to different channel coding and decoding techniques such as cyclic code, convolution codes to generate code*	

	word with high performance parameters through use of contemporary techniques (P.I.- 2.3.1) *LO 2.5 Compare different channel coding techniques based on the performance parameters. (P.I. 2.2.4)* *LO 2.6 Describe and evaluate the use of energy-efficient coding principle based on compression technique for sustainable development. (P.I.- 6.4.1)*	
03.	**Pulse Shaping for Optimum Transmission** ***Learning Objective:*** • ***To analyze and implement line coding technique in baseband digital transmission.*** • ***To help learners compare interferences in Baseband PAM Transmission.*** **Contents:** Line codes and their desirable properties, PSD of digital data. Baseband PAM transmission: Concept of inter channel and inter symbol Interference, eye pattern. Concept of equalizer to overcome ISI, Nyquist's Criterion for distortion less transmission. Duo-binary encoding and modified duo-binary encoding ***Self-Learning Topics:*** ***Types of Equalizers.*** ***Learning Outcomes:*** *A learner will be able to* *LO 3.1 Compare different Line Codes/ different types of interference in digital communication systems. (P.I.-2.2.4)* *LO 3.2 Select the best line coding technique with minimum bandwidth as a design objective for a given data. (PI- 3.1.6)* *LO 3.3 Model a duo- binary encoder for a given input data for a single bit error. (P.I.-2.3.1)* *LO 3.4 Represent graphically the types of lines codes for a given data (PI- 4.3.3)* *LO 3.5 Describe and evaluate the use of power-efficient line coding principle based on reduced interference for sustainable development. (P.I.- 6.4.1)* *LO 3.6 Develop ability to independently learn the types of equalizers. (P.I. 11.1.3).*	**04**
04.	**Digital Modulation Techniques** ***Learning Objectives:*** *To teach various Binary and M-ary Modulation Techniques.* **Contents:** Binary modulation techniques: BASK, BFSK, BPSK, M-ary Modulation techniques: QPSK, M-ary PSK, MSK, M-ary FSK, QAM, DPSK and DEPSK, probability of error in modulation schemes. ***Self-Learning Topics:*** ***GMSK*** ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Compare different digital modulation Schemes (P.I.-2.2.4)* *LO 4.2: Represent graphically the digital modulation techniques such as QPSK, M-ary PSK, M-ary FSK, MSK, M-ary QAM, and DPSK/DEPSK, for a given data (PI- 4.3.3)* *LO 4.3 Determine the Euclidean distance, bandwidth and probability of error for a digital modulation scheme. (P.I.- 1.3.1)*	**10**

	LO 4.4 Develop ability to independently learn the applications of MSK/ QAM. (P.I. 11.1.3).	
05.	**Baseband detection** ***Learning Objective/s:*** *To teach the fundamentals of baseband signals, including their characteristics, representation, and how they relate to the transmitted message.* *To help learners understand the role of baseband receivers in recovering transmitted information from modulated signals.* **Contents:** Probability of error and transfer function of baseband receivers, Integrate and dump receiver, Optimum Receiver, Matched filter, Correlator. ***Self-Learning Topics:*** ***Properties of Matched filter*** ***Learning Outcomes :*** *A learner will be able to* *LO 5.1 Apply the concept of signal to noise parameters to understand the importance of its characteristics in digital communication systems. (P.I.- 1.3.1)* *LO 5.2 Apply concepts of the optimum receiver characteristics to evaluate the probability of error in the communication system. (P.I.-1.4.1)* *LO 5.3 Compare different baseband receivers. (P.I.-2.2.4)* *LO 5.4 Describe and evaluate the use of baseband receivers with minimum probability of error for sustainable development. (P.I.- 6.4.1)* *LO 5.5 Develop ability to independently learn the properties of Matched filter. (P.I.- 11.1.3)*	**06**
06.	**Spread Spectrum Modulation** ***Learning Objective/s:*** ***To facilitate the importance of Spread Spectrum Systems in digital communication.*** **Contents:** Spread Spectrum Modulation: Need for spread spectrum modulation, pseudo noise sequence generation, direct sequence spread spectrum (DSSS). Processing gain and jamming margin, frequency–hop spread spectrum (FHSS) Application of spread spectrum: DS-CDMA. ***Self-Learning Topics:*** ***Additional real time applications of spread spectrum*** ***Learning Outcomes:*** *A learner will be able to* *LO 6.1 Apply concepts of Spread Spectrum Modulation to obtain the threshold for processing gain. (P.I.-1.4.1)* *LO 6.2 Produce and validate numerical results of Spread Spectrum characteristics to generate pseudo noise sequence with high performance parameters through use of contemporary techniques. (P.I. 2.3.1)* *LO 6.3 Compare different modulation schemes with pseudo-noise sequence used in DSSS and FHSS to spread the signal across a wider bandwidth. (P.I.-2.2.4)* *LO 6.4 Describe and evaluate the use of spread spectrum technique with reduced interference for sustainable development. (P.I.- 6.4.1)*	**06**

	LO 6.5 Develop ability to independently learn the real time applications of spread spectrum techniques. (P.I.- 11.1.3)	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.3.3	Identify suitable criteria for evaluation of alternate design solutions
4.3.3	Represent data (in tabular and/or graphical forms) to facilitate analysis and explanation of the data, and drawing of conclusions
6.4.1	Describe and evaluate engineering principles for sustainable development pertaining to relevant fields.
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. Apply the concepts of information theory in source coding. (*LO 1.1, 1.2, 1.3, 1.4*)
2. Compare different error control systems, line codes and baseband- bandpass modulation schemes. (*LO 2.5, 3.1, 4.1, 5.3, 6.3*)
3. Solve numerical based on error detection, error correction, baseband transmission, modulation and spread spectrum schemes. (*LO 2.1, 2.2, 2.3, 2.4, 2.6, 3.2, 3.3, 3.4, 3.5, 4.2, 4.3, 6.2*)
4. Analyze the performance of spread spectrum and optimum baseband detection. (*LO 5.1, 5.2,5.4, 6.1, 6.4*)
5. Develop self-learning ability in advanced topic related to digital communication such as equalizers, baseband- bandpass and spread spectrum modulation schemes. (*LO 3.6, 4.4, 5.5, 6.5*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECPCC510.1	3	3										
ECPCC510.2		3										
ECPCC510.3	3	3	3	3		3						
ECPCC510.4	3					3						
ECPCC510.5											3	
Average	3	3	3	3		3					3	

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books :

1. H. Taub, D. Schlling, and G. Saha-Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012
2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017
3. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.
4. John G. Proakis-Digital Communications, McGraw-Hill, Fourth Edition

Reference Books:

1. Simon Haykin, "Communication System", John Wiley & Sons , 5th Edition,2009.
2. Taub Schilling And Saha, "Principles Of Communication Systems", Tata Mc-Graw Hill, 3rd Edition,2007.
3. Amitabha Bhattacharya, "Digital Communication", Mcgraw Hill, 1st Edition. 2005.

Other Resources :

1. Course: Network Analysis by Prof. Tapan Kumar Bhatttacharya, IIT Kharagpur; Weblink - https://archive.nptel.ac.in/courses/108/105/108105159/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Assignments based on class notes: 10 Marks

b) Open book test: 05 Marks

c) Regularity and active participation: 05 Marks

3. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ECPEC5011	Electromagnetic Wave Theory	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC301 Engineering Mathematics-III
2. ECPCC405 Engineering Mathematics-IV
3. BSC205 Engineering Physics-II

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct Investigations of Complex Problems
4. PO8: Individual and teamwork
5. PO9: Communication
6. PO11: Life-long learning

Course Objectives:

1. To familiarize with electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. To convey Maxwell's equation to solve various electromagnetic phenomenon.
3. To develop an understanding related to electromagnetic laws and their application to solve engineering problems.
4. To convey the use of suitable computer-aided method to plot a given field problem.

Module	Details	Hrs.
	Course Introduction What is a field? What is the nature of a field? How is magnetic field produced by a current-carrying coil? How does a capacitor store energy? What is an electromagnetic wave? How does it travel? This course answers these and more questions that every electronics & telecommunication engineer should be aware of. Though electromagnetic wave theory is very well established through the works of stalwarts like Faraday, Coulomb, Gauss, Maxwell etc. it stands strong in today's world of 5G -6G communication due to the solid foundation it provides to modern communication systems. It also enables a learner to acquire imaginative thinking, analytical skills and problem-solving skills.	**01**

01.	**Co-ordinate systems and vector calculus** ***Learning Objective:*** ***1. To introduce significance of various coordinate systems with reference to electromagnetic fields.*** ***2. To help students appreciate the ideas of vector fields and various operations like gradient/curl on them.***	**07**
	Contents: Cartesian Coordinates, Circular Cylindrical Coordinates, Spherical Coordinates. Differential Length-Area-Volume, Line-Surface-Volume Integrals, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stokes's Theorem, Laplacian of a Scalar, Vector fields and their classification.	
	Self-Learning Topics: Other coordinate systems	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify co-ordinate system and its parameters to solve a given problem. (PI 2.1.2)* *LO 1.2: Identify mathematical knowledge related to differential and integral of different parameters such as length, volume, area to evaluate their values for given boundary conditions. (PI 2.1.3)* *LO 1.3: Apply fundamentals of vector field to determine gradient/divergence and curl. (PI 1.3.1)* *LO 1.4: Apply fundamentals of vector field to classify them. (PI 1.4.1)* *LO 1.5: Develop ability to learn co-ordinate systems through Team-Pair-Solo and present effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
02.	**Electrostatics** ***Learning Objective:*** ***1. To introduce concepts of force, intensity, flux density, potential and solve related problems.*** ***2. To explain how electric fields, behave in different materials.*** ***3. To facilitate understanding of Boundary condition solving and importance of continuity.***	**07**
	Contents: Coulomb's Law and Field Intensity, Electric Flux Density, Gauss's Law, Applications of Gauss's Law, Electric Potential, Electric dipole, Energy stored in electric field, Electric fields in material space- Conductors, Boundary Conditions, Poisson's and Laplace's Equations, Resistance and Capacitance. Current and current density, The continuity equation, Relaxation time, Electromotive Force.	
	Self-Learning Topics: Polarization in Dielectrics, Linear, Isotropic, and Homogeneous Dielectrics, Method of images	
	Learning Outcomes:	

	A learner will be able to *LO 2.1: Apply different laws of electromagnetics to analyse their applications. (PI 1.4.1)* *LO 2.2: Identify law of electromagnetics and apply its knowledge to determine different parameters such as force, electric field intensity, energy for a given system. (PI 2.1.3)* *LO 2.3: Apply law of electromagnetics to derive boundary conditions, continuity equation, Laplace and Poisson's equation. (PI 2.4.1)* *LO 2.4: Develop ability to learn laws of electromagnetics through Team-Pair-Solo and present effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
03.	**Magneto statics** ***Learning Objective:*** ***1. To teach various laws related to static magnetic fields with their usage.*** ***2. To help learners appreciate importance of scalar and vector magnetic potential.***	**06**
	Contents: Biot-Savart's Law, Ampere's Circuit Law, Applications of Ampere's Law, Magnetic Flux Density/Intensity, Inductances, Ampere circuital law, Magnetic vector potential and magnetic scalar potential.	
	Self-Learning Topics: Magnetic Boundary Conditions, Energy in magnetic field	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply different laws of electromagnetics to analyze their applications. (PI 1.4.1)* *LO 3.2: Identify and apply appropriate magnetostatic law to solve a given problem. (PI. 2.1.2)* *LO 3.3: Compare magnetostatic laws to select appropriate one for a given input condition. (PI. 2.2.4)* *LO 3.4: Apply fundamentals of electromagnetics to understand concepts of magnetic scalar and vector potential. (PI 1.4.1)* *LO 3.5: Develop ability to learn laws of electromagnetics, concept of magnetic scalar/vector potential through Team-Pair-Solo and present effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
04.	**Time-varying Fields and Maxwell's Equations** ***Learning Objectives:*** ***1. To relate laws studies in static and electrical magnetic fields as Maxwell's equations.*** ***2. To help learners appreciate the concept of displacement current and how it leads to modification of Maxwell's equation for time-varying fields.*** ***3. To make learners understand importance of Maxwell's work in establishing the concept of travelling energy.***	**08**
	Contents: Motional emf, Faraday's law of induction, Self-and mutual inductance, Displacement Current and Density, Maxwell's equations for static fields, Maxwell's equations for time-varying fields in point and integral forms, The Poynting theorem and Poynting Vector	

	Self-Learning Topics: Time harmonic fields	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply law of natural science such as Faraday law to determine induction. (PI 1.2.1)* *LO 4.2: Apply fundamentals of various laws for static and time-varying fields to understand significance of each of the Maxwell's equations. (PI 1.4.1)* *LO 4.3: Apply knowledge of electromagnetic laws and related mathematics to derive Maxwell's equations and (PI 2.4.1)* *LO 4.4: Identify mathematical and relevant knowledge to derive Poynting theorem. (PI 2.1.3)*	
05.	**Electromagnetic Wave Propagation** ***Learning Objective/s:*** ***1. To develop general wave equation from Maxwell's equations.*** ***2. To derive wave equation for different mediums.*** ***3. To explain concept of polarization.*** ***4. To relate what happens when the EM wave undergoes reflection.***	**08**
	Contents: General wave equation, Wave Propagation in various mediums—lossy dielectric, free space, lossless dielectric and good conductors, Polarization and its types, Reflection of a Plane Wave at Normal Incidence, Reflection of a Plane Wave at Oblique Incidence	
	Self-Learning Topics: Importance of wave polarization in mobile transmission.	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify and apply appropriate Maxwell's equation to derive general wave equation (PI. 2.1.3)* *LO 5.2: Apply Maxwell's equations and related mathematics to analyze wave propagation in various mediums.(PI 2.4.1)* *LO 5.3: Apply fundamentals of polarization to determine type of polarization from the wave equation.(PI 1.3.1)* *LO 5.4: Apply fundamentals of EM wave propagation to understand concept of reflection of a plane wave at normal incidence and oblique incidence. (PI 1.4.1)*	
06.	**Introduction to computational electromagnetics** ***Learning Objective/s:*** ***1. To help learners understand how modelling of electromagnetic fields is done through various computer aided methods.*** ***2. To develop learner's understanding about applications of these methods to some of the studied theories***	**07**
	Contents: Finite difference method-Iteration method, Band matrix method, Finite element method, Method of moments	

	Application-Microstrip lines, Solution of Laplace/Poisson and Helmotz Wave equations using Finite Difference Method	
	Self-Learning Topics: Field plotting	
	Learning Outcomes: *A learner will be able to* *LO 6.1 Define a problem, its scope and importance for purposes of investigation. (PI 4.1.1)* *LO 6.2 Apply suitable computer-aided method to determine solution of given problem and to plot field and potential lines. (PI 4.1.3)* *LO 6.3: Identify type of method and apply it's knowledge to determine solution of wave equations. (PI 2.1.3)* *LO 6.4: Compare different computer aided methods to select the appropriate one for a given input condition. (PI 2.2.4)* *LO 6.5: Apply knowledge of computational electromagnetics to analyze different applications. (PI 1.4.1)* *LO 6.6: Develop ability to learn computer aided methods independently through software simulation assignment and present effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem.
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.4	Compare and contrast alternative solutions to select the appropriate methodology.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
4.1.1	Define a problem, its scope, and importance for purposes of investigation
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
9.1.1	Read, understand and interpret technical and/or non-technical information.
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others.
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. Choose appropriate vector operator among gradient, curl and divergence to solve given field problem for particular co-ordinate system. *(LO 1.1 to LO 1.5)*
2. Apply static fields laws to describe and determine parameters for different charge configurations. *(LO 2.1 to LO 2.4)*
3. Select appropriate magnetostatic laws to determine field parameters. *(LO 3.1 to LO 3.5)*
4. Derive Maxwell's equations for static and time varying conditions. *(LO 4.1 to LO 4.4)*
5. Apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave. *(LO 5.1 to LO 5.4)*
6. Model a given field problem with a suitable computer-aided method and analyze the solution. *(LO 6.1 to LO 6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECPE5011.1	3	3						3	3		3	
ECPE5011.2	3	3						3	3		3	
ECPE5011.3	3	3						3	3		3	
ECPE5011.4	3	3									3	
ECPE5011.5	3	3									3	
ECPE5011.6	3	3		3				3	3		3	
Average	3	3		3				3	3		3	

Text Books :

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition

Reference Books :

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Electromagnetism-Problems with solutions, Ashutosh Pranik, PHI learning Private limited, 2nd edition
3. Engineering Electromagnetics, Umran S. Inan, Aziz S. Inan, Pearson publication
4. Field Theory, K.A.Ganghdhar, P M Ramanathan, Khanna Publishers

Other Resources :

1. NPTEL- Electromagnetic Theory by Prof. Pradeep Kumar, IIT Kanpur
https://www.youtube.com/playlist?list=PLFW6lRTa1g80n91bZDKR8izUxfa_TKk3J
2. NPTEL-Transmission Lines and EM Waves by Prof. R.K. Shevgaonkar**,** IIT Bombay
https://www.youtube.com/playlist?list=PL0CD49F1FAD4E6FAA

IN-SEMESTER ASSESSMENT (75 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. Class test: 5 marks
2. Software simulation assignment: 5 marks
3. Team-Pair-Solo: 5 marks
4. Regularity and active participation: 5 marks

4. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PE	ECPEC5012	Computer Communication Networks	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. Principles of communication
2. Digital communication

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5 : Modern tool usage
4. PO9 : Written communication
5. PO11: Life-long learning

Course Objectives:

1. To introduce networking architecture and protocols.
2. To educate students OSI and TCP/IP, the layer-wise functions, services, data formats, protocols, hardware devices and addresses in the OSI and TCP/IP architecture.
3. To build an understanding of various protocols so as to make students comprehend each of them.
4. To apply different addressing and routing schemes to be able to solve numerical and comparative analysis.
5. To make students apply knowledge and analyse various processes involved in networking.

Module	Details	Hrs.
	Course Introduction The "Computer Communication Networks" course is crucial for students in Electronics and Telecommunication engineering, in understanding the types of Networks related to Telecommunication. This course provides the basic terms and background insights on computer networks and related protocols essential in both academic and industry applications.	**01**
01.	**Introduction to Network Architectures and layered services** ***Learning Objective:*** *1. To educate students on the concept of formation of networks with computer devices and their identification* *2. To deliver knowledge on the OSI layered models and types of addressing used with computer networks.* *3. To introduce students about the hardware devices available at different layers and their usage in computer network.*	**06-07**

	4. To teach students the use of IP utility commands in order to troubleshoot networks.	
	Contents: Applications of computer networks. Network types: LAN, MAN, and WAN, Network topologies. OSI reference model 7 layer, 4 layer TCP/IP model, protocols at each layer, addressing used with computer networks: physical, logical, port addressing, socket addressing. Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison) Troubleshooting of network using IP utility commands.	
	Self-Learning Topics: *Review on CAN, PAN and WLAN networks*	
	Learning Outcomes: *A learner will be able to* *LO 1.1* *Apply knowledge of various network types and topologies, OSI reference model and TCP/IP model to arrive at conclusions. (PI: 1.4.1)* *LO 1.2* *Identify the types of network devices, addresses required and ports used based on the given scenarios. (PI: 2.1.3)* *LO 1.3* *Compare various network devices, their use and addressing techniques for the computer networks. (PI: 2.4.4)* *LO 1.4* *Analyse information related to a network and troubleshoot using IP utility commands . (PI: 5.2.2)*	
02.	**Physical Layer and broadband standards** ***Learning Objective:*** *1. To impart knowledge on various Broadband standards used at data link layer.* *2. To provide introduction to transmission media and impairments.*	**05-06**
	Contents: Guided transmission media: comparison among coaxial, optical fiber and twisted pair cables. Unguided transmission media and wireless standards Transmission impairments: attenuation, dispersion and noise Broadband standards: Cable modem, DSL and Fiber to the home.	
	Self-Learning Topics: *Advantages and disadvantages of various wired and wireless media*	
	Learning Outcomes: *A learner will be able to* *LO 2.1* *Identify the types of media or broadband standard applicable for a given problem statement or objective of computer networking (PI: 2.1.3)* *LO 2.2* *Compare various transmission media and utility in computer networks. (PI: 2.4.4)*	
03.	**Data Link Layer and media access protocols** ***Learning Objective:*** *1. Teach students to illustrate the error and flow control in data link layer.*	**06-07**

	2. *To introduce students ARQ techniques and medium access techniques in computer networks.* 3. *To make students compare the type of medium access protocols such as ALOHA and CSMA*	
	Contents: Data link services: Framing, Flow control, Error control at data link layer ARQ methods, Transmission efficiency in ARQ methods, Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA/CA and CSMA/CD High Level Data Link Control (HDLC): bit stuffing and de-stuffing concept.	
	Self-Learning Topics: *HDLC Frame format and configurations, Piggybacking*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply the knowledge on data link layer services and data link layer protocols to illustrate the concept of piggybacking and HDLC. (PI:1.4.1) (PI:9.1.2) (PI:11.1.3)* *LO 3.2: Determine transmission efficiency for MAC protocols. (PI:2.4.1)* *LO 3.3: Compare the type of medium access protocols such as ALOHA, CSMA and ARQ techniques. (PI: 2.2.4)*	
04.	**Network Layer : protocols and routing algorithms**	**08-09**
	Learning Objectives: 1. *To make students apply the concept of subnetting according to an organization's need and solve subnetting problems.* 2. *To make students understand how to apply routing algorithms to construct routing tables* 3. *To make students differentiate between IP versions, addressing and hardware at various layers.* 4. *To extract the understanding through illustrative examples how computer communication network helps in circuit switching and packet switching for the applications customers seek*	
	Contents: Circuit switching and packet switching principles. Internet Protocol: Principles of Internetworking, requirements, IPv4 packet header, IPv4 addressing, classful and classless addressing concept, subnetting for Internet service providers and related numericals. Introduction to ARP, RARP and ICMP **** wireshark packet capture software demonstration in class IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6) Routing in Packet Switching Networks: Routing strategies, Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF, BGP. *** cisco packet tracer demonstration during class Introduction to MPLS (Multi-protocol label switching)	
	Self-Learning Topics:	

	Super-netting concept, EIGRP protocol	
	Learning Outcomes: *A learner will be able to* *LO 4.1 : Classify the addressing, IP versions and routing algorithms with respect to the utilities and features. (PI: 2.2.4)* *LO 4.2: Apply knowledge of the different routing protocols and illustrate the preparation of routing tables.(1.4.1)(11.3.1)* *LO 4.3: Determine the subnets as per the requirements of an organization and ISP. (PI:2.1.3)* *LO 4.4: Analyse the IP header and interpret the packet information from header Fields using Open-source software tools such as Wireshark for protocol observation and CISCO packet tracer for simulation of networks (PI: 5.2.2) (PI:2.4.1)*	
05.	**Transport layer** ***Learning Objective/s:*** 1. *To develop understanding of connection oriented and connection less services with computer networks.* 2. *To provide advantages and disadvantages between protocols used at the same layer of TCP/IP protocol suite.* 3. *To make students perform the checksum calculations and header analysis for TCP and UDP.*	**07-08**
	Contents: Connectionless and Connection–oriented services at transport layer,User datagram Protocol (UDP) header, well known UDP ports, advantages and limitations of UDP service. Transmission Control Protocol (TCP): TCP Services, TCP Segment fields, checksum calculation in TCP, TCP three-way handshake, State transition diagram in TCP, advantages of TCP, Retransmission of TCP segments, Flow control, error control and congestion control in TCP, well known TCP ports, limitations with TCP.	
	Self-Learning Topics: *RTO, Keepalive and Persistence timers in TCP*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Provide insights on the TCP handshake, flow control, error control and TCP services, state transition diagram and timers. (1.4.1) (9.1.2) (11.3.1)* *LO 5.2: Perform header analysis for TCP and UDP to arrive at conclusions. (1.3.1)((PI :2.4.1)*	
06.	**Application Layer** ***Learning Objective/s:*** 1. *To introduce students port numbers associated with different applications*	**06-07**

	2. To make students aware of the security issues with computer networks and introduce possible solutions	
	Contents: Introduction to Application layer Protocols and port numbers associated with popular protocols, HTTP, SMTP , FTP, DNS and DHCP Secured protocols : HTTPs, SSL and IPSec	
	Self-Learning Topics: *Remote login using TELNET and SSH*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply the knowledge on the concepts of DNS, FTP, SMTP and DHCP to the given scenario. (2.1.3)* *LO 6.2: Enlist the application layer related protocols specifying their utilities. (1.4.1)* *LO 6.3 Justify with reasoning the use of various remote login procedures, domain name resolution and the host configuration. (1.4.1)(9.1.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
2.4.1	Apply engineering mathematics and computations to solve mathematical models and analyse results
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
5.2.2	Demonstrate proficiency in using discipline-specific tools.
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to –

1. Identify the protocol usage from the layers in TCP/IP model and requirement of network hardware devices, transmission media and medium access methods.*(LO 1.1, LO 5.1, LO 6.2)*
2. Perform analysis on IPv4 header, transport layer headers and determine the subnetting and routing table entries. (*LO 3.2, LO 4.2, LO 4.3, LO 4.5)*
3. Distinguish between the various network architectures, protocol suites, transport and application layer protocols, routing algorithms, IP versions and medium access control methods. (*LO 1.2, LO 1.3, LO 2.1, LO 2.2, LO 3.3, LO 4.1)*
4. Analyze the layers in TCP/IP model and troubleshoot using various opensource software platforms. *(LO 1.4, LO 4.4, LO 5.2)*
5. Justify by appropriate reasoning the need of layer-wise protocols, secured transmission and the use of wired or wireless media for computer networks (*LO 3.1, LO 6.1, LO 6.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPEC5012.1	3	3							2		3
ECPEC5012.2	3	3									
ECPEC5012.3	3	3									
ECPEC5012.4	3	3			2				2		
ECPEC5012.5	3	3							2		3
Average	3	3			2				2		3

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books :

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH,2013
2. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013
3. J. F. Kurose and K. W. Ross," Computer Networking: A Top-Down Approach", Addison Wesley. ," Computer Networking: A Top-Down Approach", Addison Wesley, 5th Edition, 2010.

Reference Books :

1. Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second, . Edition, Fourth Edition, 2008.
2. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education, 2015.
3. Data and Computer Communications, William Stallings, 10th Edition, Pearson Education, 2014.

4. Understanding communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning

Other Resources :

1. By Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty | IIT Kharagpur
2. Computer Networks and Internet Protocol - Course (nptel.ac.in)

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

a) In-class simulations and Assignments: 10 Marks
b) Quizzes (04) : 05 Marks
c)Regularity and active participation: 05 Marks

3. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PE	ECPEC5013	Digital VLSI	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. BSC102 Engineering Physics-I
2. ECPCC303 Electronics Devices and Circuits
3. ECPCC304 Digital Circuit Design

Program Outcome addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solution
4. PO5: Modern Tool Usage
5. PO8: Individual and Team work
6. P09: Communication
7. PO11: Lifelong Learning

Course Objectives:

1. To learn the basic concepts of MOSFETs, layout, fabrication. and solve the problems to analyse the MOSFETs.
2. To analyse performance metrics of CMOS Inverter, NAND, NOR gate.
3. To design combinational and sequential circuits using different design styles.
4. To analyse the working of RAM and ROM array.
5. To provide exposure on static timing analysis and CMOS testing.

Module	Details	Hrs.
	Course Introduction The field of CMOS Integrated circuits is broadly divided into digital and analog CMOS circuits. However, the boundary between classical digital and analog CMOS design is becoming very less, especially with the challenges presented by nanometer scale fabrication technologies, low operating voltages and frequencies. Here we start with the fabrication and end with the testing of CMOS circuits under different conditions.	**01**
01.	**VLSI Technology- Circuit, Layout and Fabrication** ***Learning Objective:*** ***1. Analyze and interpret the basics of MOSCAP and MOS Transistor.*** ***2. To analyze and design the concepts of Stick Diagram, Layout and fabrication processes.***	**10-13**
	Contents: • Overview of VLSI Design Flow, Metal Oxide Semiconductor Structure, MOS under External Bias, Operation of MOS Transistor. Threshold voltage equation and energy band diagram of MOSFET, controlling of threshold voltage. MOSFET current-voltage characteristics, MOSFET	

	Capacitance, Small-Geometry Effects-. Scaling, short channel effects • Layout: Stick diagrams, Design Rule Background, Micron/Lambda Design Rule. • Fabrication: CZ Process, Process(Oxidation, Epitaxial, Lithography, Diffusion, Ion Implantation, Metallization) flow of NMOS and CMOS. ***Self-Learning Topics:****ITRS Website, Comparison of depletion and enhancement type of MOSFETs* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to realize the operation, characteristics and band diagram of MOSFET. (P.I.-1.3.1)* *LO 1.2: Apply concepts of semiconductor physics and material science to comprehend Threshold Voltage, MOS Capacitance, Scaling and Short Channel Effects. (P.I.-1.4.1)* *LO 1.3: Identify the aspect ratio and lambda rules to construct layout of combinational logic circuits for a given boolean expression. (P.I.-2.1.3)* *LO 1.4: Identify existing methods for analyzing different process flow of fabrication for NMOS, PMOS and CMOS. (P.I.-2.2.3)* *LO 1.5: Develop ability to learn custom layouts through Think-Pair-Solo and present effectively. (PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
02.	**Combinational CMOS Logic Circuits** ***Learning Objective:*** 1. *To analyze basics of CMOS Inverter, NAND and NOR gate for different performance metrics.* 2. *To design CMOS Inverter, NAND, NOR and complex logic circuits.* **Contents:** • CMOS Inverter Operation, Characteristics, Static and Dynamic Analysis (Noise margin, Propagation delay and Power dissipation), Design of CMOS Inverter and Layout of CMOS Inverter, CMOS Latch-up. • Realization of CMOS NAND gate, NOR gate, Complex CMOS Logic Circuits Layout of NAND ,NOR and Complex CMOS Circuits ***Self-Learning Topics:*** *Logical Effort* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply fundamental engineering concepts to identify the operation of CMOS Inverter, NAND and NOR gate (P.I.-1.3.1)* *LO 2.2: Identify basic concepts of CMOS Inverter and analyze all the basic performance metrics of VLSI design (Noise margin, Propagation delay, Power dissipation and Area.in static and dynamic state (P.I.- 2.1.3)* *LO 2.3: Identify the relevant data from the resources to design NAND and NOR gate in terms of CMOS Inverter to arrive to an optimal design. (P.I-3.3.3,)* *LO 2.4: Develop ability to learn to solve the critical voltages of CMOS Inverter and design it through Think-Pair-Solo and present effectively. (P.I-1.4.1, P.I-2.3.1, P.I-3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	**6-8**
03.	**MOS Design Logic Styles** ***Learning Objective:*** 1. ***To design, implement and verify combinational and sequential logic circuits using various MOS design styles.***	**9-11**

	2. ***To introduce VLSI performance metrics and various tradeoffs.***	
	Contents: • Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C^2MOS • Clocked CMOS SR Latch, CMOS JK Latch, MS –JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles • Realization of Shift Register, MUX, Decoder using above design styles ,1-bit full adder	
	Self-Learning Topics: Corner Stitching analysis.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply fundamental engineering concepts to solve problems of Combinational design styles. (P.I-1.3.1).* *LO 3.2: Apply concepts of electronics engineering and digital systems to solve engineering problems on sequential design styles (P.I-1.4.1).* *LO 3.3: Analyze the basic concepts of different design styles for combinational and sequential circuits leading to conclusions in terms of merits and limitations. (P.I-2.4.4)* *LO3.4: Identify the relevant data from the resources (design styles), analyze and design the circuit for a given expression. (P.I.-3.3.3)* *LO 3,5: Identify suitable criteria for evaluation of alternate design solutions using different styles for applications of digital design such as full adder ,Decoder etc. and give the limitations for the same based on performance metrics.(P.I-3.2.3,P.I-2.4.3).*	
04.	**Semiconductor Memories** ***Learning Objectives:*** 1. *To learn the working of NAND based ROM array, NOR based ROM array* 2. *To provide analysis and design using simulator/editors on SRAM and DRAM*	**4-6**
	Contents: • ROM array-NAND and NOR based ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM, Peripheral Circuits • Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	
	Self-Learning Topics: *Fowler Nordheim Tunneling*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply core principles of engineering to classify semiconductor memories. (P.I-1.4.1)* *LO 4.2: Apply fundamental engineering concepts to solve the problems of volatile memories. (P.I-1.3.1)* *LO 4,3: Identify and design NAND/NOR based ROM array for a given matrix using open-source tool. (P.I-3.1.6, P.I- 5.1.2)* *LO 4.4: Identify the mathematical approach that applies to NAND and NOR flash memory. (P.I-2.1.3)* *LO 4.5: Extract the understanding objectives and limitations of 6T SRAM / 3T DRAM (P.I-2.4.4)*	

	LO 4.6: Design 6T SRAM / 3T DRAM using layout editor for the given specification. (P.I-3.3.3,P.I-5.3.3)	
05.	**Static Timing Analysis** ***Learning Objective/s:*** *1. To introduce the various STA checks for timing closure and Step-by-step structured timing analysis.* **Contents:** • Introduction to basic characteristics of setup and hold analysis, data check and latch timing, Slew, load, clock checks and timing graph • Clock to q delay, library setup, Hold time and jitter, Textual Timing reports and hold analysis, On Chip variation, OCV timing and pessimism removal • Introduction to open timer, netlist definition and constraint creation commands. ***Self-Learning Topics:*** ***Learning Outcomes :*** *A learner will be able to* *LO 5.1: Apply fundamental engineering concepts to comprehend the concept of basic characteristics of setup and hold analysis. (P.I.-1.3.1).* *LO 5.2: Apply fundamentals of open timer to solve the various STA checks. (PI-1.4.1)* *LO 5.3: Analyze concepts of clk-qdelay to create eye diagram in jitter analysis accounting to setup and hold timing analysis with conclusions in terms of limitations. (P.I-2.4.4)* *LO 5.4: Identify the basics of On Chip variation, OCV timing and pessimism removal that applies to a given problem. (P.I-2.1.3).*	**4-6**
06.	**CMOS Testing** ***Learning Objective/s:*** *1.To learn about the testing processes of CMOS circuits under different conditions..* **Contents:** CMOS Testing, Need for Testing, Test Principles, Design Strategies for Test, Chip Level and Board Level Test Techniques. ***Self-Learning Topics:*** ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply and identify the importance of testing in the VLSI design and manufacturing lifecycle. (P.I-1.4.1)* *LO 6.2: Apply fundamental test principles to understand key concepts like controllability and observability in digital circuit testing. (P.I.-1.3.1)* *LO 6.3: Identify test challenges in modern high-density integrated circuits.for a testable design system. (P.I.-2.1.3)* *LO 6.4: Compare techniques used in wafer-level, die-level, and package-level testing. (P.I.-2.2.4)*	**3-5**

	Course Conclusion	**01**
	Total	**45**

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPEC5013.1	3	3						3	3		3
ECPEC5013.2	3	3	3					3	3		3
ECPEC5013.3	3	3	3		3						
ECPEC5013.4	3	3									
ECPEC5013.5	3	3									
Average	3	3	3	3	3			3	3		3

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solutions to select the best methodology.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications Curriculum Structure and Syllabi (R-2024) – B. Tech. in Computer Engineering
3.2.3	Identify suitable criteria for evaluation of alternate design solutions
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems
5.3.3	Recognize sources of error in measurements, modelling or simulations and verify credibility of results.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
9.1.1	Read, understand and interpret technical and/or non-technical information.
9.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap

11.1.3 Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes:

1. To comphrend qualitative knowledge about MOSFET operation, characteristics, layout and fabrication processes of integrated circuit using MOS transistors *(LO 1.1, LO 1.2, LO1.3, LO1.4, LO 1.5)*
2. Compute, analyse and design the performance parameters of basic building blocks like CMOS Inverter, NAND and NOR with layouts. *(LO 2.1, LO 2.2, LO2.3, LO 2.4*)
3. Analyse and design the working of various design style, CMOS combinational, sequential and semiconductor memories used in VLSI Design. *(LO 3.1, LO 3.2, LO3.3, LO3.4, LO 4.1, LO 4.2, LO 4.3,LO4.4,LO4.5,LO4.6*)
4. Apply the concepts of STA to set constraints, analyse reports generated by static timing analysis tools. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4*)
5. Comprehend and analyse various CMOS testing tools, processes under different fault models, test methodologies, and design-for-testability strategies *(LO 6.1, LO 6.2, LO 6.3, LO 6.4*)

Text Books :

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2012
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.
3. CMOS VLSI Design-A Circuits and Systems Perspective, Neil H.E Weste, David Harris, Ayan Banerjee, 3 rd Edn, Pearson, 2009

Reference Books :

1. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley, 2nd Edition, 2013
2. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, Student Edition, 2013.
3. Neil H. E. Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, 3rd Edition.
4. Introduction to VLSI Design-Mead & Convey,BS Publications,2010.

Other Resources :

1. NPTEL Course: CMOS Digital VLSI Design y Dr. Sudeb Dasgupta, IIT Roorkee: -Web link- CMOS Digital VLSI Design - Course
2. NPTEL Course: VLSI Design Verification and Test, By Dr.Santosh Biswas, Prof. Jatindra Deka, IIT Guwahati. Web link- https://nptel.ac.in/courses/106103016

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. *Numerical Assignment/s (min 20 problems)/Simulations – 05 Marks*
2. *Class test based on above numerical assignment – 05 Marks*
3. *Activity based study-Think pair solo and preparing report: 05 Marks*
4. *Regularity and active participation:05 Marks*

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination(MSE) carrying 30% weightage, and the syllabus covered from MSE to ESE carrying 70% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ECPEC5014	ROBOTICS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. BSC101- Engineering Mathematics-I
2. ESC101- Engineering Mechanics
3. ECPCC405- Engineering Mathematics-IV
4. ECSBL402- Simulation Lab

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO6: The engineer and The World
5. PO8: Individual and teamwork
6. PO9: Communication
7. PO11: Life-long learning

Course Objectives:

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics.
3. To exhibit the manipulator differential motion and control
4. To educate on various path planning techniques
5. To familiarize the dynamics and control of manipulators
6. To acquaint about the localization, planning and navigation

Module	Details	Hrs.
	Course Introduction Robotics course provides the fundamental information and real-world skills needed to plan, design, program, and operate robotic systems. Robotics is an interdisciplinary field that builds devices that can do tasks either autonomously or with human help by integrating principles from computer science, mechanical engineering, electrical engineering, and artificial intelligence.	**01**

01.	**Introduction to Robotics** ***Learning Objective:*** ***To facilitate understanding of laws of robotics and select the robot for desired application.***	**03**
	Contents: Introduction to robotics- History, growth; Robot applications- Manufacturing industry, Defence, rehabilitation, medical, marine, autonomous vehicle, Laws of Robotics.	
	Self-Learning Topics: ***Overview of robotics and its evolution. Hard and soft automation in robotics.***	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental concepts of coordinate transformations for a desired application to determine their position and orientation. (P.I.- 1.3.1)* *LO 1.2: Apply concepts of hard and soft automation that influence the performance of a robotic arm. (P.I.- 1.4.1)* *LO 1.3: Determine design objectives of various robots, their functional requirements and arrive at specifications related to accuracy, reach, stroke and load handling capacity (P.I.- 3.1.6)* *LO 1.4: Identify relevant data from the given robot specifications and arrive at a best fitting design solution (P.I.- 3.3.3)* *LO 1.5: Describe and evaluate the Laws of Robotic principles for sustainable development based on application for preserving the safety requirement. (P.I.- 6.4.1)* *LO 1.6: Apply principles of preventive engineering and sustainable development to a robot application based on the Laws of Robotic. (P.I.- 6.4.2)*	
02.	**Robot Kinematics** ***Learning Objective:*** • *To familiarize the robotic motion using mathematical representation with desired constraints.* • *To impart and interpret the robot kinematics.*	**10**
	Contents: Mathematical representation of Robots, Robot mechanisms; Kinematics- coordinate and homogeneous transformations, Denavit Hartenberg (DH) parameters, Forward kinematics and Inverse Kinematics (upto 5-axis robotic arm). Motion constraints: Jacobians, Trajectory Planning, unicycle, differential drive and omnidirectional.	
	Self-Learning Topics: ***Mathematical problems based on homogeneous coordinate transformations.***	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental concepts of mathematical transformations to solve problems based on yaw- pitch- roll mechanism (P.I.- 1.3.1)* *LO 2.2: Apply concepts of trajectory planning to solve the motion constraint problem. (P.I.-1.4.1)*	

	LO 2.3: Identify the kinematic parameters, variables in link and joint structure of a robotic arm to solve problems based on transformations. (P.I.- 2.1.2) *LO 2.4: Identify sources of motion constraints in a robot and state the limitations to overcome the constraints (P.I.- 2.4.3)* *LO 2.5: Present results as a team, with smooth integration of contributions from all individual efforts in case study implementation of a robot application. (P.I.- 8.3.1)* *LO 2.6: Create clear constructed, and well-supported documents and presentation for the existing robotic prototype. (P.I.- 9.1.2)*	
03.	**Path Planning and AI in Robotics** ***Learning Objective:*** • *To educate path planning using algebraic principles.* • *To introduce the robotic position in work space envelope using position and orientation technique.* • *To develop learner's knowledge to apply the algebraic technique as well as AI algorithm to analyze the robotic path.* **Contents:** Path Planning: Joint space technique, Use of p-degree polynomial, Cubic polynomial, Cartesian space technique, Parametric descriptions, Straight line and circular paths, Position and orientation planning. Voronoi and hybrid approach. AI Algorithms: Probabilistic robotics, Breadth and Depth First Search algorithms. ***Self-Learning Topics:*** ***Bug based path planning algorithms.*** ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply fundamental concepts of position and orientation to locate the destined position in a workspace environment. (P.I.-1.3.1)* *LO 3.2: Apply the concepts of path planning algorithm to determine the characteristics related to navigation. (P.I.-1.4.1)* *LO 3.3: Identify the need for appropriate algorithm for implementing path planning mechanism (P.I.- 3.1.1)* *LO 3.4: Identify suitable AI algorithm for a desired application with multiple design solutions (P.I.- 3.2.2)* *LO 3.5: Present results as a team, with smooth integration of contributions from all individual efforts in case study implementation/ designing a robot application with appropriate path planning principle. (P.I.- 8.3.1)* *LO 3.6: Comprehend the Bug based path planning algorithms and analyze technical information for feasibility, viability, sustainability, etc. (P.I.- 11.3.2)*	**08**
04.	**Actuators** ***Learning Objectives:*** *To educate about the actuator and feedback control system used in designing robotic motion.* **Contents:**	**08**

	Actuators (electrical)- DC motors, BLDC servo motors, Sensors, sensor integration, Control – PWM, joint motion control, feedback control, Computed torque control.	
	Self-Learning Topics: ***Fundamentals of control theory and feedback systems, basic control strategies such as PID (Proportional-Integral-Derivative) control to regulate robot motion.***	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply fundamental concepts of feedback control mechanism to design robotic motion in a workspace environment. (P.I.-1.3.1)* *LO 4.2: Apply the concepts of actuators and sensors to determine the robot parameters in a particular workspace envelope. (P.I.-1.4.1)* *LO 4.3: Breakdown and analyze the complex feedback control mechanism in robotic motion control and analyse by proper assumptions. (P.I.- 2.2.1)* *LO 4.4: Compare and contrast different feedback control mechanisms to select the best method. (P.I.- 2.2.4)* *LO 4.5: Comprehend the fundamentals of control theory and feedback systems to regulate robot motion and analyze technical information for feasibility, viability, sustainability, etc. (P.I.- 11.3.2)*	
05.	**Service Robotics** ***Learning Objective/s:*** ***To instil knowledge of Simultaneous Localization and Mapping (SLAM) algorithms for an application-based robot.***	**08**
	Contents: Need for service robots. Localization: Challenges, Map Representation- Probabilistic Map based Localization Monte Carlo localization, Algorithms for simultaneous localization and mapping (SLAM). Planning and navigation: Path planning overview, Cell decomposition path planning, Potential field path planning-Obstacle avoidance, Landmark based navigation-Globally unique localization, Positioning beacon systems- Route based localization, fault detection/tolerance systems; multiple coordinated vehicles; and networked vehicles.	
	Self-Learning Topics: ***Obstacle avoidance techniques to help robots navigate in dynamic environments.***	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply fundamental concepts of Cell decomposition mechanism to design path planning algorithms. (P.I.-1.3.1)* *LO 5.2: Apply the concept of localization to determine the pick and place location. (P.I.-1.4.1)* *LO5.3: Identify different localization algorithms with high fault detection/tolerance capability and its need in navigating the robot with multiple design solutions. (P.I.- 3.2.2)* *LO 5.4: Apply principles of preventive engineering and sustainable development of a service robot based on SLAM algorithms (P.I.- 6.4.2)*	

06.	**Marine Robotics** ***Learning Objective/s:*** ***To explain the role of robotic systems in the marine environment.***	**06**
	Contents: Introduction to marine robotics and robotic configurations; autonomous underwater gliders (AUGs), autonomous underwater vehicles (AUVs), and remotely operated underwater vehicles. • Applications (optional) - collision avoidance, line following, occupancy grid methods. • Basics of missile guidance - Introduction to missiles, missile guidance laws (pursuit, line-of-sight, proportional navigation), capturability analysis, for maneuvering and non-maneuvering targets. • Applications of guidance strategies to cooperative control (optional)- multi-vehicle path planning, collision avoidance, docking problems.	
	Self-Learning Topics: *Case studies from India, Republic of Korea, Japan and USA.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply fundamental concepts of control theory to design marine robotic systems for stable movement and navigation. (P.I.-1.3.1)* *LO 6.2: Apply engineering concepts to determine factors like buoyancy, materials, power requirements, and environmental durability for marine applications (P.I.- 1.4.1)* *LO 6.3: Identify the need for appropriate guidance strategies for implementing marine robot application (P.I.- 3.1.1)* *LO 6.4: Apply principles of preventive engineering and sustainable development to an engineering activity relevant to the marine based robot. (P.I.- 6.4.2)* *LO 6.5: Create clear constructed, and well-supported documents and presentation for the existing marine robotic prototype. (P.I.- 9.1.2)* *LO 6.6: Analyse and comprehend technical information as to how marine robots communicate with surface control stations and other robots in the absence of traditional wireless communication methods for feasibility, viability, sustainability, etc. (P.I.- 11.3.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No. **P.I. Statement**

1.3.1 Apply fundamental engineering concepts to solve engineering problems.
1.4.1 Apply electrical engineering concepts to solve engineering problems.
2.2.1 Breakdown complex problem into interconnected sub parts and analyse by proper assumptions/ justification from information and resources.
2.2.4 Compare and contrast alternative solutions to select the appropriate methodology.
2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.4.3 Identify sources of error in the solution process, and limitations of the solution.

3.1.1 Recognize that need analysis is key to good problem definition.
3.2.2 Identify suitable criteria for evaluation of alternate design solutions
3.3.3 Identify relevant data from the given resources and arrive at the best fitting design solution for particular specifications.
6.1.1 Identify social, environmental and health related issues with the help of relevant viewpoints from stakeholders and propose engineering solutions.
6.1.3 Identify and evaluate the potential risks to human health and environment due to an engineering product design or modelling technique.
6.4.1 Describe and evaluate engineering principles for sustainable development pertaining to relevant fields.
6.4.2 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.
8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
9.2.2 Deliver effective oral presentations to technical or non- technical audiences.
11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Apply the basic concepts of robotics. (*LO 1.1- LO 1.5*)
2. Analyze the differential motion and statics in robotics. (*LO 2.1- LO 2.4*)
3. Select optimum path planning algorithm to determine parameters related to pick and place operations for workspace envelope. (*LO 3.1- LO 3.4)*
4. Apply and analyze the dynamics and control in robotics industries. (*LO 4.1 - LO 4.4*)
5. Develop self-learning ability to design and document an automated manipulator in advanced topic related to Robotic application based on automation, path planning algorithms, actuators, service and marine robots. (*LO2.5, LO 2.6, LO 3.5, LO3.6, LO 4.5, LO 5.1- LO 5.4, LO 6.1- LO 6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPE5014.1	3		3			3					
ECPE5014.2	3	3									
ECPE5014.3	3		3								
ECPE5014.4	3	3									
ECPE5014.5	3		3			3		3	3		3
Average	3	3	3			3		3	3		3

Text Books :

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 2000.
3. JohnJ. Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
4. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
5. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004
6. T. Fossen, "Guidance and Control of Ocean Vehicles", Chichester New York, US, 1994.
7. J. N. Newman, "Marine Hydrodynamics", MIT Press, USA, 1997.
8. T. Fossen, "Marine Control Systems: Guidance, Navigation and Control of Ships, Rigs and Underwater Vehicles", Marine Cybernetics, Trondheim, Norway, 2002.

Reference Books:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
5. Riadh Siaer, The future of Humanoid Robots- Research and applications, Intech Publications, 2012.
6. K. D. Do and J. Pan, "Control of Ships and Underwater Vehicles: Design for Underactuated and Nonlinear Marine Systems", Advances in Industrial Control, 1st edition, Springer, Germany, 2009.
7. G. Griffiths, "Technology and Applications of Autonomous Underwater Vehicles", Ocean Science and Technology, Vol. 2, CRC Press, USA, 2002.
8. R. Sutton and G. Roberts, "Advances in Unmanned Marine Vehicles", IEE Control Series, Institution of Engineering and Technology, USA, 2006.

Other Resources:

1. NPTEL/ Swayam Course: Robotics and Control: Theory and Practice by Prof. N. Sukavanam and Prof.M. Felix Orlando, IIT Roorkee.
   Web Link: https://onlinecourses.nptel.ac.in/noc25_me69/preview

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) In- class assignment based on flip class activity: 10 Marks
b) Open notes test: 05 Marks
c) Regularity and active participation: 05 Marks

3. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC506	HDL Programming Laboratory	2

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. ECPCC304: Digital Circuit Design
2. ECLBC302: Digital Circuit Design Laboratory
3. ECLBC405: Microcontrollers and Embedded System Laboratory

Program Outcomes addressed:

1. PO 3: Design/Development of Solutions
2. PO 4: Conduct investigations of complex problems
3. PO 5: Modern tool usage
4. PO 6:The Engineer and The World
5. PO 7: Ethics
6. PO 8: Individual and teamwork
7. PO9: Communication

Course Objectives:

1. To provide the learner the comprehension of HDL design flow.
2. To implement the Verilog design on programmable logic board using computer-based aids (Tools)
3. To identify test pattern and testing devices for the design implemented on programmable logic design

Module	Detailed Contents	Hrs
	This course strength the skill set in the field of Very Large-Scale Integration (VLSI) design. The programmable logic devices are the first choice of design engineer to embed the digital design in semiconductor technology to reduce time to market. This skill lab course also prepares them to keep pace with the changing trends of VLSI technology and the requirements of an ever-growing VLSI design industry. The HDL programming lab is also the prerequisite for system architecture, ASIC designs as well SoC field.	**02**
01.	**Introduction to HDL** ***Learning Objective/s:*** *To design the arithmetic circuits i.e., divisor, multiplier and common factor identifier using hardware descriptive language and debug, test /validate it using computer aided design tool.* **Contents:**	**6**

	HDL design flow, Lexical Conventions – Numbers, comments, whitespace, operators, strings, identifiers, keywords. Complier directives – define, include, ifdef, endif, else, timescale, System Tasks - display, monitor, time, stop, Modules, Gate level modeling, Behavioral Level Modeling, Data Flow Modeling, Test Bench ,HDL coding style . **Suggested list Experiments:** i. Develop the Verilog code of greatest common divisor. Write the test bench to simulate and verify the code. Use system task and complier directives in test bench to monitor the results. ii. Develop the Verilog code of least common multiple. Write the test bench to simulate and verify the code. Use system task and complier directives in test bench to monitor the results. iii. Develop a circuit to divide an 8-bit dividend by a 4-bit divisor to obtain a 4-bit quotient. Write the test bench to simulate and verify the code. Use system task and complier directives in test bench to monitor the results. iv. Develop of a multiplier for unsigned binary numbers that multiplies a 4-bit number by a 16-bit number to give a 20-bit product. Note: Any two experiments from above suggested list or similar experiments to be conducted . ***Self-Learning Topics:*** *Merits and demerits open source simulation tools for HDL.* ***Learning Outcomes :*** *A learner will be able to* *LO 1.1: Identify the Verilog construct, system task, complier directives and key words to edit, test, debug and simulate the arithmetic circuits design i.e., divisor, multiplier and common factor identifier by applying test bench using modern tool. (P.I.-4.2.1) (P.I.-4.3.1) (P.I.-5.1.1) (P.I.-5.3.3)*	
02.	**HDL code to IC** ***Learning Objective/s:*** *To design the combinational circuits i.e., divisor, multiplier and common factor identifier and implement it on programmable logic device with functional verification.* **Contents:** Programmable logic devices-FPGA and CPLD , FPGA Architectures and Technologies, FPGA Architectures and Technologies, Steps for HDL code to IC –Translate, Mapping, Place and Route, Configuration stream, downloading into PLD, Summary of the implementation. **Suggested list Experiments:** i. Implement greatest common divisor on programmable logic device. ii. Implement least common multiple on programmable logic device. iii. Implement divider on programmable logic device. iv. Implement multiplier on programmable logic device. Note: Any two experiments from above suggested list or similar experiments to be conducted . ***Self-Learning Topics:***	**6**

	Implement 4 bit adder ,subtractor, counter on programmable logic device. ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Apply HDL to bit stream generation steps to implement the digital design on programmable logic device and validate it by selecting appropriate testing and measuring devices such as logic analyzer or keys, LED, power supply, multi-meter with suitable test inputs(pattern). (P.I.-3.2.1) (P.I.-3.2.2) (P.I.-4.1.3) (P.I.-4.2.1).* *LO 2.2: Analyze the summary of implementation. (P.I.-4.3.3).*	
03.	**FSM using Verilog** ***Learning Objective/s:*** *To design control circuit for traffic lights, automobile warning indicators and score board and implement it on programmable logic device with functional verification.* **Contents:** Synchronous Sequential Circuit: Finite state machine, Sequential Verilog Construct for finite state machines, State machine synthesis, Timing Analysis of Logic circuits, Clock Skew, Clock Jitter, Test bench for sequential circuits. **Suggested list Experiments:** i. Design and implement traffic light controller for the intersection of street A and B. (Customized design problem). ii. Design and implement Scoreboard and controller. This can display scores from 0 to 99 (decimal). The input to the system should consist of a reset signal and control signals to increment or decrement the score. iii. Thunderbird car has three left (LA, LB, LC) and three right (RA, RB, RC) tail lights, which flash in unique patterns to indicate left and right turns. Design and Implement the controller to flash the desired pattern. Note: Any two experiments from above suggested list or similar experiments to be conducted . ***Self-Learning Topics:*** *Controller for streetlight Management System* ***Learning Outcomes :*** *A learner will be able to* *LO 3.1: Design and implement the control circuit i.e., Finite state machine using hardware descriptive language for road safety applications. (P.I.-3.1.6) (P.I.-3.2.1) (P.I-.6.1.1) (P.I-.6.2.1)* *LO 3.2: Test the design sustainability using specified procedure and analyze the summary of implementation (P.I.-4.2.1), (P.I.-4.3.3).*	**8**
04	**RISC Processor Design** *Learning Objective/s:* *To design 4-bit RISC processor using hardware descriptive language and implement/optimize the design implement it on programmable logic device with functional verification* **Contents:** RISC Philosophy, RISC Architecture – Memory, Register set, Instruction set, Instruction decoder, Data path, Control logic, Pipe line for Fetch, decode and execute, Primitives and its usage in design ,Efficient coding	**8**

	styles, Partitioning for synthesis, Pipelining, Resource sharing, Optimizing arithmetic expressions, Hardware Testing and Design for Testability, Boundary scan, built in self-Test	
	Suggested Experiment: Design 4-bit RISC processor with following features 1. 4 x 16 RAM interface – Data Memory 2. 8 x 32 ROM interface – Program Memory 3. 4 bit 8 Registers –R0 to R7 4. 4 bit ALU to perform addition, subtraction, logical operations (any 4) 5. Instruction Set - any 10 instructions to support ALU ,data moves	
	Self-Learning Topics: *Floating Point arithmetic* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Design and implement the RISC processor using hardware descriptive language for given specification. (P.I.-3.1.6) (P.I.-3.2.1 (P.I.7.2.4)* *LO 4.2: Demonstrate/Present the design methods, test pattern, results and designed processor in teams. (P.I.-4.2.1) (P.I.-4.3.3) (P.I.-7.1.1)) (P.I.-8.2.4) (P.I.-8.3.1) (P.I.-9.1.2) (P.I.-9.2.2)*	
Total		**30**

P.I. No.	**P.I. Statement**
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.1	Apply design principles in engineering tools to build models/prototypes in order to develop engineering design solutions
3.2.2	Identify suitable criteria for evaluation of alternate design solutions
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures, test vectors.
4.3.1	Use appropriate procedures, tools, and techniques to conduct experiments and collect data
4.3.3	Represent data (in tabular and/or graphical forms) to facilitate analysis and explanation of the data, and drawing of conclusions
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.3.3	Recognize sources of error in measurements, modelling or simulations and verify credibility of results.
6.1.1	Identify social, environmental and health related issues with the help of relevant viewpoints from stakeholders and propose engineering solutions.
6.2.1	Comprehend legal requirements relevant to engineering design and propose solution complying to engineering standards.
7.1.1	Follow ethical practices to create a document.
7.2.4	Use code of ethics while working with a diverse group of people for a team assignment/project.
8.2.4	Assess individual contributions to a team activity and provide feedback

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.

9.2.2 Deliver effective oral presentations to technical or non- technical audiences.

Course Outcomes: A learner will be able to -

1. Develop Verilog codes of arithmetic circuits with test bench and perform the functional simulation using computer aided design tools. *(LO 1.1)*
2. Design and implement arithmetic circuits on PLD and perform functional verification. *(LO 2.1, LO 2.2)*
3. Design the traffic controller, automobile indicators used for road safety applications. *(LO 3.1, LO 3.2)*
4. Design RISC Processor. *(LO 4.1, LO 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECSBL603.1				3	3						
ECSBL603.2			3	3							
ECSBL603.3			3	3		3					
ECSBL603.4			3	3				3	3		
Average			3	3	3	3		3	3		

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books :

1. Digital Systems Design using Verilog , Charles H. Roth, Jr, Lizy Kurian John, Byeong Kil Lee, 2015,Independence : Nelson Engineering
2. Digital Design With an Introduction to the Verilog HDL, VHDL, and System Verilog, Morris Mano Michael D. Ciletti, Sixth Edition, Pearson

Reference Books :

1. Fundamentals of Digital Circuits, Anand Kumar, Fourth Edition, 2018, PHI learning
2. Digital Fundamentals, Thomas L. Floyd, Eleventh GlobalEdition,2015, Pearson Prentice Hall
3. Digital Electronics Principles and Applications, Mandal, First Edition, 2010, McGraw Hill Education
4. A Verilog HDL Primer, J. Bhasker, Third Edition, 1997, Star Galaxy Press

5. Embedded System, Raj Kamal , Fourth Edition,2020, McGraw Hill

Other Resources :

1. https://www.vlab.co.in/broad-area-electronics-and-communications

2. "Using Practical Examples in Teaching Digital Logic Design", Dr. Joseph P Hoffbeck, University of Portland

A. IN-SEMESTER ASSESSMENT (25 Marks)

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observation, interpret results/conclusion and prepare a brief report as per requirement

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Interpretation of digital design
- Implementation and summary of the design
- Oral
- Students will be randomly allocated a problem statement to base on HDL programming laboratory work. The student ts will be asked to interpret and break down the design to write the HDL code of the given problem statement. The proposed breakup and HDL code will be checked by the examiners (Internal and External) and evaluated out of 5 Marks.
- Then the student will be allowed to for the code scripting, Functional verification of proposed design.
- Students will be allocated 1 hour to implement design. Both the examiners for its correctness verify the obtained result. The weightage of the implementation/verification is 10 Marks
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks

Course Type	Course Code	Course Name	Credits
LBC	ECLBC507	Digital Communication Laboratory	01

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. ESL206 -Basic Electronics Engineering Laboratory
2. ECLBC301- Electronic Devices and Circuits Lab
3. ECLBC404- Principles of Communication Lab

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO3: Design/Development of solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Modern tool usage
5. PO6: Engineer and the world
6. PO7: Ethics
7. PO8: Individual and team work
8. PO 9: Communication
10. PO11: Life-long learning

Course Objectives:

1. To familiarize students with source coding and error control coding techniques
2. To acquaint different line coding methods
3. To impart the conceptual knowledge on digital modulation and demodulation in time and frequency domain.
4. To enhance their problem- solving and analysis skills through different simulation tools for digital communication applications.

Module	Details	Hrs.
	Course Introduction This course is designed to provide students with a practical understanding of key digital communication techniques, with a special focus on shift keying methods such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). Students will perform a series of experiments using trainer kits and software tools to simulate and implement these modulation techniques. These experiments will help bridge the gap between theoretical concepts and real-world applications, giving view of how digital signals are generated, transmitted, and received.	**01**
01.	**Source coding and channel coding-based experiments** ***Learning Objective:*** ***1. To interpret and observe different coding techniques.***	**08**

	2. To measure technical parameters of the observed signal and reach to a valid conclusion.	
	Task 1: **Implement source coding technique to compress a file and determine the code word.** *LO 1.1: Produce and validate results for entropy and efficiency in source coding techniques through skilful use of contemporary engineering techniques. Inculcate ability to work in a group with a mutually involvement manner and present individual contribution with valid reason. (P.I.- 2.4.2, 7.2.3, 8.2.4)* **Task 2:** **Implement an error correcting code for error detection and correction (Eg: Hamming code).** *LO 1.2: Analyse encoded data with error possibility and its limitation and adapt to the current technologies with new developments on error correcting codes. (P.I.- 4.3.2, 11.2.2)* **Task 3:** **Write a simulation code for generating a code word, detecting the error in the code word and correcting the error based on channel coding and decoding technique.** *LO 1.3: To use modern software tool to implement Channel encoding and decoding techniques to determine the code word and present individual contribution with valid reason. (P.I.- 5.1.2, 8.2.4)* *LO 1.4: Generate and prepare clear, well-constructed technical engineering documents on source and channel coding techniques. (P.I- 9.1.2)*	
	Self-Learning Topics: ***Insights on Octave software***	
02.	**Baseband modulation-based experiments** ***Learning Objective:*** ***1. To interpret and observe different line codes.*** ***2. To measure power spectral density of the observed signal and reach to a valid conclusion***	**08**
	Task 4: **Use the trainer kit in a group for a digital pulse based modulator/ demodulator including Line coding techniques and observe the waveforms at transmitter-receiver section.** *LO 2.1: Produce and validate results for digital pulse based modulator/ demodulator system through skilful use of contemporary engineering techniques. Inculcate ability to work in a group with a mutually involvement manner and present individual contribution with valid reason. (P.I.- 2.4.2, 7.2.3, 8.2.4)* **Task 5:** **a. Write a code/ simulate the circuit to generate various Line codes and observe the corresponding power spectral density (PSD).** b. **To simulate the circuit built on digital pulse based modulator/ demodulator in any circuit simulator software.** *LO 2.2: Use appropriate procedures, tools, and techniques to conduct experiments based on baseband modulations- demodulations and observe the results. Adapt to the current modulation techniques with additional features. (P.I.- 4.3.1, 11.2.2).* *LO 2.3: Demonstrate proficiency in using discipline-specific tools like DSO and spectrum analyzer to generate and display different line codes, digital pulse modulation-demodulation schemes and to effectively observe the associated power spectral density (PSD), signal efficiency and bandwidth. (P.I.- 5.2.2)*	
	Self-Learning Topics: ***Baseband receiver design***	

03.	**Bandpass modulation-based experiments**	**08**
	Learning Objective: ***1. To implement the circuit based on various parameters of modulation scheme to generate the modulated signals and measure the modulation characteristics.*** ***2. To simulate modulation schemes.***	
	Task 6: **Generation and detection of binary, quadrature and M-ary type of modulation and demodulation techniques based on trainer kit and observe the PSD to measure power and bandwidth of the system.** *LO 3.1: Produce and validate results of key parameters such as power and bandwidth from the digital modulated system through skilful use of contemporary engineering techniques and present individual contribution with valid reason. (P.I.- 2.4.2, 8.2.4)* *LO 3.2: Recognize the need for various modulation techniques to overcome the problem based on distortions and apply principles of preventive measures and sustainability to the modulation technique. (P.I.- 3.1.1, 6.4.2)* **Task 7:** **Simulate a digital modulation- demodulation based circuit/ Write a code and analyze digital modulation schemes using modern software tool.** *LO 3.3: Identify modern software engineering tools to simulate and analyze digital modulation schemes using design specific tools. Present results as a team, with smooth integration of contributions from all individual effort to synthesize the modulation- demodulation (P.I.- 5.1.1, 8.3.1)* *LO 3.4: Generate clear, well-constructed, and well-supported technical engineering document on various digital modulation techniques based on modern tools (P.I- 9.1.2)*	
	Self-Learning Topics: ***Insights on trainer kit and its use.***	
04.	**Spread spectrum modulation schemes** ***Learning Objectives:*** ***1. To develop, simulate and interpret the Pseudo-Random code based on spread spectrum parameters.*** ***2. To present the simulated results with teamwork.***	**06**
	Task 8: **Generation of a Pseudo-Random (PR) Sequence based on trainer kit and observe the effects of PR sequence on the transmitted signal.** *LO 4.1: Produce and validate results of key parameters such as Jamming margin, noise and pseudo-noise sequence through skilful use of contemporary engineering techniques and present individual contribution with valid reason. (P.I.- 2.4.2, 8.2.4)* **Task 9:** **Simulate the Spread Spectrum technique for a data signal and demonstrate its resistance to noise.** *LO 4.2: Identify modern software engineering tools, techniques and resource to implement and analyze spread spectrum techniques and present results as a team, with smooth integration of contributions from all individual effort on executed circuits based on spread spectrum techniques (P.I.- 5.1.1, 8.3.1)* **Task 10:** **Simulate a GPS-like system with spread spectrum technique to understand how spread spectrum is used for high-accuracy positioning.** *LO 4.3Recognize the need for PR sequence generator to overcome problems and apply principles of preventive measures and sustainability to the spread spectrum modulation technique application like GPS system (P.I.- 3.1.1, 6.4.2)*	
	Self-Learning Topics: --	

	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques
3.1.1	Recognize that need analysis is key to good problem definition.
4.3.1	Use appropriate procedures, tools, and techniques to conduct experiments and collect data.
4.3.2	Analyse data for trends and correlations, stating possible errors and limitations
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.4.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.
8.2.4	Assess individual contributions to a team activity and provide feedback
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
11.2.2	Adapt to the current technologies regarding new developments in relevant field

Course Outcomes:
A learner will be able to -

1. Analyze source and channel coding, modulation- demodulation and spread spectrum techniques on simulation software/ trainer kit. *(LO: 1.1, 2.1, 3.1, 4.1)*
2. Synthesize in a group the design of a source and channel coding, baseband- band pass modulation and spread spectrum technique to produce the desired results. *(LO: 1.2,1.3, 2.2, 2.3,3.3,4.2)*
3. Analyze the need for modulation techniques to overcome the associated problems by applying preventive measures to attain sustainability. *(LO: 3.2, 4.3)*
4. Prepare well documented report on experiments based on source and channel coding and modulation- demodulation techniques. *(LO: 1.4, 3.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECLBC507.1		3					3	3				
ECLBC507.2				3	3			3			3	
ECLBC507.3			3			3						
ECLBC507.4									3			
Average		3	3	3	3	3	3	3	3		3	

Textbooks:

1. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017
2. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014

Reference Books:

1. S. R. S. Prasanna- Digital Communication Systems Engineering,
2. M. K. Simon, M. S. Alouini- Digital Communications: A Discrete-Time Approach
3. Henry R. Krieger- MATLAB for Engineers and Scientists
4. Andrea Goldsmith- Digital Communications: Fundamentals and Applications
5. Robert H. Morelos-Zaragoza- Practical Digital Communications

Suggested breakup of distribution

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observation, interpret results/conclusion and prepare a brief report as per requirement.

b. Practical Test1– 5 Marks

Students will be assigned an experiment based upon the first 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

c. Practical Test2– 5 Marks

Students will be assigned an experiment based upon the last 50 % of the practical experiments from the list, which they have to perform. Students will be evaluated by lab instructor based on the parameters mentioned in (a).

d. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/Theoretical knowledge
- Practical knowledge
- Oral

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to perform the same. The students will be asked to write the theory related to the experiment. The write-up is checked by the examiners (Internal and External) and evaluated out of 05 Marks.
- Then the student will be allowed to perform the experiment.
- Students will be allocated 1 hour to perform the experiment. The results are then checked by both the examiners for its correctness. The weightage of the successful done experiment is 10 Marks
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LBC	ECLBC508	Electromagnetic and Antenna Design Laboratory	01

Examination Scheme		
Continuous Assessment	**End-Semester Examination (ESE)**	**Total**
25	25	50

Pre-requisite:

1. BSC205 – Engineering Physics-II

Program Outcomes addressed:

1. PO2:Problem analysis
2. PO3:Design/Development of solutions
3. PO 4:Conduct investigations of complex problems
4. PO5: Modern tool usage
5. PO6:Engineer and the world
6. PO8: Individual and team work
7. PO9:Report writing
8. PO11:Life long Learning

Course Objectives:

1. To familiarize students with theoretical and practical expertise in designing, simulating, fabricating, testing, and optimizing antennas and related electromagnetic systems.
2. To summarize the concepts of array antennas such as analysis and synthesis of radiation patterns.
3. To prepare students to tackle real-world challenges in antenna design and electromagnetic wave propagation, with a strong understanding of both the simulation and hardware aspects of antenna system.
4. To enhance their problem- solving, measurement, and analysis skills while gaining hands-on experience in cutting-edge antenna technologies.

Module	Details	Hrs.
	Course Introduction This course bridges theory and practice, allowing the learner to explore the fascinating principles of electromagnetics and their application in designing and analyzing antennas. Through hands-on experiments and simulations, the learner will: • Understand the behavior of electromagnetic fields. • Learn how antennas transmit and receive signals effectively. • Gain proficiency in modern design tools and techniques for antenna analysis.	**01**

	The laboratory experience is designed to cultivate problem-solving skills and innovation, preparing you for real-world challenges in wireless communication, radar systems and beyond. Some of the most common and popular uses of antennas are for mobile phones, Wi-Fi routers, laptops, radios, TVs, cellular systems, satellite dishes and much more. Wearable antennas can be used for a variety of applications, including GPS trackers, glucose monitoring, breast cancer detection, and wearable thermometers.	
01.	**Fundamental concepts of Electromagnetics** ***Learning Objective:*** 1. *To develop in-depth understanding of the mathematical and physical principles governing EM wave behavior in various environments and to learn about the different regions in the electromagnetic field surrounding a source or antenna.* 2. *To apply the equation to determine power transmission in antenna systems.*	**06**
	Task I: **Use the trainer kit in a group to establish the relationship between field strength of radiated wave with distance and correlate it with inverse square law.** *LO1.1:Analyse concepts of electromagnetic to comprehend radiation principles and present individual contribution with valid reason.(8.2.4,2.2.2)* **Task II:** **Use the antenna trainer kit in a group to establish that the transmitting and receiving radiation patterns of an antenna are equal and correlate it with reciprocity theorem of antennas.** *LO1.2:Demonstrate relationship through measurements or simulations that the transmitting and receiving radiation patterns of an antenna are identical in well-created and supported documents. (4.1.4,9.1.2)*	
	Self-Learning Topics: Introduction to Static fields	
02.	**Types of Antennas and its parameters** Learning Objective:*To understand various types of antenna parameters, analyze and interpret the graphical representation of radiation patterns*.	**08**
	Spoken tutorials can be given on: Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity,Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency. Types of antennas: Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas Broadband antenna :Helical and Log Periodic antenna Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector Yagi antenna Patch Antenna: Microstrip antenna ,different types of Feeding Techniques.	

	Task III : Plotting of radiation pattern in a frequency range from 800MHz -1.25 GHz • monople and dipole antenna. • Yagi Uda antenna. • loop antenna • end side and broad side array They will also manually plot and measure antenna parameters : Gain,Directivity,Efficiency,RadiationPattern,bandwidth,Polarization,Beamwidth. *LO 2.1: Apply and analyze the practical methodology of electromagnetic principles for setting up and aligning antennas with transmitter and receiver systems and present individual contribution with valid reason.(2.4.4,4.3.1,8.2.4)* **Task IV** Plotting of radiation pattern for antennas from 1.25 GHz to 5.4 GHz. Measurements of gain , VSWR ,S parameters of microstrip antenna using Vector Network analyzer . *LO 2.2:Acquire resources to measure and plot the radiation pattern of different types of antennas (e.g., Yagi, horn, patch).(4.1.2,9.1.2)*	
	Self-Learning Topics: Anechoic chamber *https://www.youtube.com/watch?v=YI2l-ohdvVw* *Vector Network analyzer* ***https://www.youtube.com/watch?v=Sb3q8f0NBZc***	
03.	Software simulation of antennas ***Learning Objective:*** 1. *To become proficient in using industry-standard software tools for simulating antenna designs. for optimizing antenna designs, improving parameters like bandwidth, gain, and directivity.*	**06**
	A spoken tutorial session can be given to students before the simulation explaining the basic design principles of antennas design using HFSS. **Task V** Design of Rectangular Microstrip Patch antenna with different feed techniques viz., inset, coaxial probe, proximity coupled feed. The following parameter of antennas will be simulated and compared for better results in different feeding techniques. Gain,	

	Radiation Pattern, polarization, Beamwidth Front-to-back ratio.	
	Self-Learning Topics:*Microstrip patch design using HFSS design.* *https://www.youtube.com/watch?v=vHUbV_7f_dE*	
	Learning Outcomes: *A learner will be able to* *LO 3.1:To gain proficiency in using antenna design and simulation software and arrive at required specification.(5.2.2,3.1.6)* *LO 3.2:Develop the ability to interpret and analyze simulation results to refine antenna designs and present individual contribution with valid reason.(2.4.4,8.2.4)* *LO 3.3:Compare the effect of feeding techniques on parameters like return loss, bandwidth, and radiation efficiency and effectively document it.(2.2.4,9.1.2)*	
04.	Antenna fabrication (Course projects) ***Learning Objectives:*** 1. *Learn how to design and fabricate different types of antennas (e.g., dipole, patch, Yagi) for specific applications to help understand the material selection and structural requirements for antenna prototypes.* 2. *Gain knowledge of various testing equipment, including vector network analyzers (VNA), spectrum analyzers. And lso to learn various fabrication methods, such as PCB etching for microstrip antennas, metal bending for wire and monopole antennas.*	**08**
	Any one of the following. Task VI: Design and implement patch antenna for short-range wireless communication system. Design and analysis of a compact WiMAX and WLAN band notched planar mono pole antenna for Bluetooth applications. Design a Wide-band log periodic antenna operating from 800MHz to 6GHz with 10 dipoles is designed and is realized on 1.6 mm Epoxy FR4 substrate for field strength meter. Students will design,implement the antenna and prepare a technical paper.	
	Self-Learning Topics: ***Automated process of antenna fabrication*** ***https://www.youtube.com/watch?v=Wgw61-tSV3Q***	
	Learning Outcomes: *A learner will be able to*	

	LO 4.1:To gain insights into materials and techniques used for fabricating antennas, including PCB etching, metal machining, and soldering to implement the project effectively as a team(4.3.1,8.2.4) *LO 4.2:To gain knowledge of various testing equipment, including vector network analyzers (VNA), spectrum analyzers and effectively document the results through implementation of projects through adequate research literature review.(4.1.3,9.3.3,11.1.3)* *LO 4.3 :Ability to design an societal useful and real life application antenna like wifi application..(3.1.5,6.2.2,11.1.3)*	
	Course Conclusion	**01**
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
2.2.2	Identify resources to assemble/integrate information using mathematical tools.
2.2.4	Compare and contrast alternative solutions to select the appropriate methodology.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
3.1.6	Determine design objectives, functional requirements and arrive at specifications
4.1.2	Examine the relevant methods, tools, and techniques of experiment, design, system calibration, data acquisition, analysis and presentation
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
4.1.4	Establish a relationship between measured data and underlying physical principles.
4.3.1	Use appropriate procedures, tools, and techniques to conduct experiments and collect data
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.2.2	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
8.2.4	Assess individual contributions to a team activity and provide feedback
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
9.3.3	Comprehend literature, carry out background search and prepare a paper/patent draft.
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. To analyze given antennas for improved gain,efficiency and radiation pattern characteristics. *(LO1.1,LO 2.1,LO3.3*)
2. To design various types of antennas using software simulation tools.*(LO1.2,LO2.2,LO3.1 ,LO3.2)*
3. To fabricate an antenna for a given real life applications in a group.*(LO4.1,LO4.2,LO4.3)*

4. To prepare a technical paper/patent related to the antenna design and implementation. *(LO4.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLC508.1		3		3				3	3		
ECLC508.2			3		3			3	3		
ECLC508.3			3			3		3	3		
ECLC508.4			3			3		3	3		3
Average		3	3	3	3	3		3	3		3

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books :

1. Antenna Theory: Analysis and Design *by Constantine A. Balanis*
2. Antennas and Wave Propagation *by John D. Kraus and Ronald J. Marhefka*
3. Microwave Engineering *by David M. Pozar (for advanced concepts related to antennas and RF design)*

Reference Books :

1. Microstrip Antenna Design Handbook *by Ramesh Garg et al.*
2. Planar Antennas for Wireless Communications *by Kin-Lu Wong*
3. Modern Antenna Design *by Thomas A. Milligan*
4. Handbook of Antenna Design" by A.W. Rudge, K. Milne, A.D. Olver, and P. Knight
5. Small Antennas: Miniaturization Techniques & Applications" by Volakis, Chen, and Fujimoto

Other Resources :

1. Coursera: *Antenna Design and Analysis* by top universities https://www.coursera.org/learn/microwave-antenna
2. edX: *Electromagnetic Waves and Antennas* by MIT https://ocw.mit.edu/courses/6-013-electromagnetics-and-applications-spring-2009/
3. Udemy: *Practical Antenna Design: From Theory to Simulation* https://www.udemy.com/course/antennas-fundamental-parameters-theory-and-design
4. NPTEL (India): *Antenna Design and Applications* https://archive.nptel.ac.in/courses/108/101/108101092/

IN-SEMESTER ASSESSMENT (75 MARKS)

a. Practical Exercises- 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to complete the task assigned in the experiment description, record observation, interpret results/conclusion and prepare a brief report as per requirement.

b. Students need to write a paper based on their course project implementation. 10 marks

This paper will be in IEEE format.

c. Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Course Project Evaluation) (25 Marks)

Two examiners, one Internal and one External will do the evaluation.

Students will be assessed based on these parameters:

- Problem formulation
- Design
- Simulation skills
- Implementation of design
- Quality of paper.

Students will then be appearing for presentation of their course projects in front of both Internal and External examiners.

Course Type	Course Code	Course Name	Credits
AEC	AEC 502	PROFESSIONAL COMMUNICATION & ETHICS-2	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Teamwork
3. PO9 : Communication
4. PO11: Life-long learning

Course Objectives:

1. To inculcate in students, professional and ethical attitude, effective communication skills, team work and a multidisciplinary approach.
2. To provide students with an academic environment where they will be aware of the need for excellence, leadership and lifelong learning to build a successful academic & professional career.
3. To create awareness about professional ethics and codes of professional practices.
4. To prepare students for a successful academic and/or professional career that meets the global academic and/or corporate requirement by providing students to work on multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork, and other interpersonal skills.

Module	Details	Hrs.
	Course Introduction The curriculum of Professional Communication and Ethics-2 is designed to provide students with an academic environment that promotes a professional and ethical attitude as they participate in individual and team activities. The practical sessions will supplement the learner's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global industrial and corporate requirements. The curriculum will create an awareness of professional ethics and the standard code of conduct. It will further inculcate within the budding engineer the social commitment as responsible technical citizens. It will enhance the learner's team building capacities,	**01**

	interpersonal skills and leadership skills so as to become a well-rounded professional in their field of expertise.	
01.	**EMPLOYABILITY SKILLS** ***Learning Objectives:*** *1. Customised writing skills and Content Development: To develop effective writing skills to craft a clear, concise, and compelling Statement of purpose, formal letters and resumes for a specific purpose.* *2. To instil productive and efficient skills to participate confidently and constructively in group discussions and interviews for employability* *3. To inculcate Ethical Communication & Empathetic Listening*	
	Contents: **1.1 Business Correspondence** o Letter Writing (Principles, Format, Structure, Content, Types) o Job Application Letter o Joining Letter o Resignation Letter o Resume Writing **1.2 Statement of Purpose/ Letter of Intent or Interest** o Purpose o Elements of SOP/LOI o Structure o Tips for writing effective and ethical SOP/LOI **1.3 Verbal Aptitude Tests** modeled on CAT,GRE,GMAT,IELTS **1.4 Group Discussions**: Purpose, parameters of evaluating, Types of GDs (Traditional, Case-based & Role Plays), GD Etiquettes, and Importance of inclusivity, respectful listening and expression of diverse ideas for a common goal. **1.5 Personal Interviews:** Preparation, Types of questions, Types of interviews and modes of interviews. Types: Structured, Stress, Behavioural, Problem Solving & Case-based, Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual **1.6 Significance of Ethical approach during Group Discussions and Interviews** o Respectful listening o Speaking Assertively o Inclusivity of diverse individuals o Mindfulness and openness to different ideas o Common Goal of Consensus	**03**
	Self-Learning Topics: ***Watch recordings of professional interviews from online resources.(ex: Civil Service interviews), IIM and UPSC GDs***	

	Activities: *1. Prepare an SOP for admission procedure in a reputed university.* *2. Participate in GDs on a given topic followed by Mock Interview.* *3. Attempt Verbal Aptitude and Comprehension Tests.* *4. Write a Job Application/Resignation/Request/Enquiry letter in the learned format* *5. Write a Resume as a fresh graduate trainee for a specific post.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Write clear, concise and professional letters of various types that effectively convey information, build relationships and achieve professional objectives.(9.1.3, 9.2.3, 9.3.2, 11.1.1)* *LO 1.2: Rationally apply gained knowledge of group discussions and aptitude tests for continuous improvement and professional growth in academia and industry. (8.1.2, 8.2.1, 11.1.1.)* *LO 1.3: Exhibit the ethical code of conduct by treating all team mates with respect and dignity, by listening attentively to each member, and encouraging diversity of ideas during a GD. (7.3.1, 8.1.1, 8.2.2,8.2.3, 8.2.4, 9.2.3)* *LO 1.4: Demonstrate through group discussions and mock interviews, the ability to effectively identify unethical conduct and arrive at ethical decisions through strong leadership skills and respectfully lead a team or oneself to the desired goal. (7.1.1,8.1.2,8.2.1,8.2.3, 8.2.4, 8.3.1,9.2.2, 9.2.3)* *LO 1.5: Exhibit a calm demeanor by effectively preparing for competitive exams through mock tests which contain comprehending logical instructions, analysis, problem solving and verbal aptitude assessment (8.2.4, 9.1.1,11.1.1)*	
02.	**INTERPERSONAL SKILLS & ETHICS** ***Learning Objectives:*** 1. *Develop Problem Solving & Critical Thinking: To help budding engineers understand the importance of interpersonal skills and demonstrate creativity, resourcefulness, along with enhanced communication in personal and professional settings.* 2. *Self-Management & Ethical Awareness: To create awareness of Ethical and Social Responsibility towards individual and society by fostering self and team management leading to increased productivity and job readiness.*	**03**
	Contents: **2.1 Interpersonal Skills (implementation in all AE activities)** o Emotional intelligence o Effective Leadership o Team Building o Conflict Management o Negotiation & Ethical Conflict Resolution o Time management, o Assertiveness **2.2 Importance of Ethics in Interpersonal Relations** o Ethical and Inclusive Decision making. o Ethics in relation to Emotional Quotient	

	Self-Learning Topics: Follow industry leaders and experts on social media or read articles on topics related to corporate ethics and social responsibility. ***Activity:*** 1. *Listen to podcasts that discuss ethics, communication and interpersonal skills, such as "The TED Radio Hour" or "How I Built This" and conduct a GD on its learnings.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the learned interpersonal skills in various A.E. activities such as Report presentations, drafting business plans and SOP in an accepting, respectful and inclusive manner. (7.3.1,8.1.1, 8.1.2, 8.2.1, 8.2.2, 9.2.1, 9.2.3)* *LO 2.2: Apply the awareness of ethics while participating in a well-organized, time bound and constructive GD on topics raising ethical and moral concerns. (7.2.2, 7.3.1,8.2.1, 8.3.1, 9.2.3)* *LO 2.3: Apply empathetic and effective speaking skills utilizing ethical values and principles to resolve any social problem while working in a diverse team for group activities. (7.2.2, 7.3.18.1.1, 8.2.1, 8.2.2, 8.2.3, 9.2.1, 9.2.2.)* .	
03.	**ADVANCED TECHNICAL WRITING:PROJECT/PROBLEM BASED LEARNING** ***Learning Objective:*** *1. Structure & Organisation: To enable the learner to craft a well-structured technical report, utilizing a logical flow with clear introduction, body and flow, ensuring clarity and coherence in their writing.* *2. Effective Communication: To enhance the ability to communicate complex information clearly and concisely, using relevant visual aids and making the information accessible to technical and non-technical audience.*	**03**
	Contents: **3.1 Technical/Academic Report** o **Classification of reports on the basis of**: Subject Matter, Time Interval, Function, Physical Factors. o **Parts of a long formal report**: Front Matter, Main Body and Back Matter. o **Language and style of Reports:** Grammar, Tone, Style, Vocabulary, Format of the report from title page to appendices. **3.2 Definition, purpose and types of Proposal** o Parts of a Proposal**:** Elements, Scope and Limitations, Conclusion o Technical Proposal/Synopsis **3.3 Technical Paper Formats (APA/IEEE)** **Parts of a Research paper**: o Title Page o Abstract, o Introduction o Problem Statement/Hypothesis o Research methods, o Data Search (Primary/Secondary) o Quantitative/ Qualitative Analysis o Discussion,	

	o Delimitations, o future scope and o References. o Appendix o Acknowledgement **3.4 Significance of Presenting and Publishing a Research Paper** o Reading Secondary Data o Looking for research gaps o Understanding Need to fill research gap o Creating a Problem Statement o Writing a Synopsis o Writing an academic paper in the APA/IEEE format	
	Self-Learning Topics: ***Read academic research papers and look for gaps in the research area.*** ***Activity*:** *1. Prepare an Academic Research Paper on any technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *The learner will be able to* *LO3.1: Write, individually or as a team, a research paper, with logical & rational progression of ideas, effectively, in a time bound manner to everyone's understanding (8.3.1, 9.1.3, 9.2.3)* *LO3.2: Read, comprehend, and interpret previous research/ secondary source data and clearly state the purpose of research using the IEEE format. (9.1.1,9.1.3,11.3.1)* *LO3.3: Demonstrate the ability to use critical thinking to find gaps in research, interpret the technical and non-technical data and present it with clarity. (9.1.1, 9.1.3, 11.1.2, 11.3.1)* *LO3.4: Apply gained knowledge of technical writing for continuous improvement in academia and professional growth. (11.1.1)*	
04.	**TECHNICAL/BUSINESS PESENTATIONS** ***Learning Objectives:*** *1. The development of effective presentation structure and content for academic and technical presentation with the help of ICT* *2.Capacity building for delivering confident and persuasive presentation to both technical and non-technical audience individually or in a team.*	**02**
	Contents: **4.1 Effective Presentation Strategies:** o Purpose of a presentation, o Understanding the audience, location and the event, o Arranging the material, structuring the presentation, o Making effective slides and platform skills. **4.2 Group Presentations:** o Working with a mixed team (Diversity) o Sharing responsibility in a team (Delegation) o Creating the content together (Uniformity) o Transition phases and Coordination. (Teamwork)	

	o Time Management (Individual and Team) **4.3 Individual Presentations:** o Introduction of Self and Topic o Understanding the audience, building rapport o Time Management o End with Q n A, Feedback	
	Self-Learning Topics: *Watch YouTube videos of presentations like TED TALKS on motivational topics* ***Activity*:** *1. Prepare an academic research paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Demonstrate efficacious and seamless presentation skills to all audiences as an individual and a team with impeccable leadership qualities through proper delegation, problem solving and management (8.1.2, 8.2.1,8.3.1, 9.1.3, 9.2.2, 9.3.2)* *LO4.2: Engage with a diverse team and a mixed audience, during presentations, keeping in mind their uniqueness and differences. (7.3.1.,8.1.1,8.1.2,8.3.1,9.2.2, 9.2.3)*	
05.	***CORPORATE ETHICS*** ***Learning Objective/s:*** 1. *Ethical Principles & Frameworks: To aid the learner to differentiate between various codes of conduct and ethics in the social and professional world.* 2. *Analyse & Resolve Ethical Dilemmas: To enforce the significance of ethical citizenry & generate awareness on the importance of IPR and its consequences*	**02**
	Contents: **5.1. Intellectual Property Rights : Significance, Duration, Laws** o Copyrights o Trademarks o Patents o Geographical Indication o Industrial Designs o Trade Secrets **5.2. Start- Up Skills:** o Financial Literacy o Risk Assessment o Data Analysis. **5.3. Gender Equity & Inclusivity at the Work Place** o Study on Cases related to Gender Equity in India & Global o Corporate Social Responsibility o Inclusivity at the work place o Corporate Code of Conduct	
	Self-Learning Topics: Read a biography on a Business Leader/Philanthropist, Collect information on some failed startups. Assess and analyse the reasons for their failure.	

	Activity: 1. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* 2. *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Utilise professional, moral and ethical principles to identify wrong conduct and suggest ethical solutions through IPR, Gender Equity and Corporate ethics (7.1.1, 7.2.2, 7.3.1)* *LO 5.2: Critically evaluate various socioeconomic, gender issues of discriminatory nature, while emulating equality and open mindedness in all teams, sectors and activities. (7.1.1, 7.2.2,7.3.1, 8.1.1, 8.1.2, 9.2.3)* *LO 5.3: Employ the awareness of IPR to avoid or solve unethical practices in professional life by following standard rules and practices and emerge as a productive team member and a progressive leader. (7.1.1,7.2.2, 8.2.1, 8.2.2, 11.1.1)* *LO 5.4: Assess a failed business plan, analyse reasons for failure and suggest viable solutions as a team keeping in consideration both the individual and team effort. (8.2.1, 8.3.1,9.1.3, 11.1.2)*	
	Activities for Ability Enhancement (Practical Sessions):	**30**
	Contents: 1. *Write a job application letter, a joining letter, a letter of apology, a request letter. Attach a Resume to the Job Application letter. Follow Standard formats and protocols for each document. (5M)* 2. *Prepare an Academic Research Paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper (5M) + Presentation & Group Dynamics (5M)]* 3. *Prepare an SOP for admission procedure in a reputed university. (5M)* 4. *Participate in GDs on given topic followed by Mock Interview ((10 M)* 5. *Attempt Verbal Aptitude and Comprehension Tests(5M)* 6. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* ***OR*** *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)* 7. *Active Participation & Regularity (5M)*	
	Activities will start in the inverted pyramid, viz., with group activities first so as to build confidence and ending with solo presentations in the form of research paper presentation or Gender Equity presentation. *Group Discussion, Interview Skills, Presentation skills will have at least three mock drills before the final assessment of the same.* *Rigorous development of the English language, social and professional etiquette will be the praxis*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies
7.3.1	Apply and exhibit universal human values and a diverse and inclusive mind-set, free of discrimination
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution andleadership skills
8.2.2	Treat other team members respectfully
8.2.3	Listen to other members
8.2.4	Maintain composure in difficult situations
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that themain point is clear
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.2.3	Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team.
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	State the rationale for the requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Communicate and present effectively and ethically with mixed media in both oral and written forms business reports and documents which will in turn provide a solid foundation for their future managerial roles. (*LOs 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1)*
2. Exhibit the skill set required for successful employability while expressing ethical, assertive and inclusive leadership skills. (*LOs 2.1, 2.2, 2.3, 3.2, 4.2, 4.3, 5.2)*
3. Develop a critical thinking acumen to prepare for and give various competitive exams, emerge successful in group discussions and conduct healthy debates. (*LOs 1.3, 2.1, 2.2, 2.3, 3.1, 4.2)*
4. Develop creative and mindful thinking while demonstrating the knowledge of professional and personal etiquettes & ethics, such as diversity and inclusivity, in the global environment. (*Los 1.2, 2.2, 2.4,1.3, 3.2, 4.3, 5.1, 5.2, 5.3, 5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
AEC502.1							3	3	3		3
AEC502.2							3	3	3		3
AEC502.3							2	3	3		3
AEC502.4							3	3	3		3
Average							3	3	3		3

Reference Books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin:*
2. *Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021).
3. *Business communication today*. Upper Saddle River, NJ: Pearson.
4. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
5. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South Western Cengage Learning.
6. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow,

England: Pearson.
7. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
8. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
9. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Other Resources :

1. NPTEL Course: https://archive.nptel.ac.in/courses/109/104/109104030
   Dept. of Humanities and Social Sciences, IIT Kanpur, A Course on Communication Skills

CONTINUOUS INTERNAL ASSESSMENT (50 Marks)

1. Assignments on Resume Writing and Business Correspondence (5M)
2. Prepare an Academic Research Paper (3500-4000 words) on any one socio-technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper/ IEEE (5 M) + Presentation & Group Dynamics. (5M)]
3. Prepare an SOP for admission procedure in a reputed university. (5M)
4. Participation in Final GD on concrete/abstract topic followed by Mock Interview. (10M)
5. Verbal Aptitude Tests (5M)
6. Analyse a Case Study on the topic of Gender Equity & Inclusivity and present (APA) OR
   Analyse a failed start up present your case to a mixed audience (APA) (10M)
7. Regularity and Active participation (5M)

Course Type	Course Code	Course Name	Credits
MNP	ECMNP503	MINI PROJECT- 2A	01

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Modern Tool Usage
6. PO6 : The Engineer & World
7. PO7 : Ethics
8. PO8 : Individual & team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
  - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
  - 20 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
  - 20 marks for the Final Report & Presentation
  - 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester V:

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
  - The first review will focus on finalizing the problem statement (topic approval).
  - The second review will centre on finalizing the proposed solution.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

Course Type	Course Code	Course Name	Credits
HSS	HSS502	Entrepreneurship	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Pre-requisite: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer & The World.
5. PO7: Ethics
6. PO10: Project Management & Finance
7. PO11: Life-long learning

Course Objectives:

1. To develop Entrepreneurial mindset amongst the learners.
2. To promote Entrepreneurship as life-skills to improve quality of life, skills of creation and management of entrepreneurial pursuits.
3. To explore paths of the innovation through the creative problem-solving skills
4. To familiarize with the steps involved in 'idea to product' development.
5. To get acquainted with the preparation of pitch at ideation, business idea presentation and funding stages

Module	Details	Hrs
00	**Course Introduction:** This course aims to equip individuals with the knowledge, skills, and mindset needed to identify and pursue new business opportunities. It aims to foster an entrepreneurial culture and mindset to help develop the next generation of entrepreneurs who can create jobs, drive economic growth, and contribute to the society. Entrepreneurship is a life skill that will help an individual succeed in a variety of scenarios, both personal and professional. By its very nature, entrepreneurship is an interdisciplinary field that draws from a range of disciplines, including business, economics, engineering, and social sciences. Some of the key topics covered in Entrepreneurship Course include opportunity recognition, market research, business planning, financing, marketing, and management while emphasizing the development of critical thinking, creativity, risk-taking, and problem- solving skills.	1

1	**Fundamentals of Entrepreneurship**	5-6
	***Learning Objectives**:* • *To gain knowledge about the concepts and principles of entrepreneurship, including opportunity recognition and value creation.* • *To develop an entrepreneurial mindset and skills that will enable them to identify, evaluate, and pursue viable business opportunities with confidence.*	
	Contents: Introduction to Entrepreneurship, Entrepreneurial Mindset, Opportunity Identification, Market Analysis & Customer Research, Business Models & Go-to-Market, Funding and Financial Management, Marketing Aspects, Scaling the Venture and Growth Strategies: *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Understand the concept of Entrepreneurship* • *State the myths, advantages and limitations of Entrepreneurship* • *Interpret and analyze market research data and customer analysis to make informed business decisions.* • *Discuss the steps in the process of Entrepreneurship*	
2	**Technological Innovation and Entrepreneurship**	4-5
	Learning Objectives: • *To enhance creative problem-solving skills and to examine the importance of innovation in business success.* • *To identify the types of Innovation* • *To gain knowledge for taking an idea to product development stage while protecting the idea with IPR.*	
	Content: Foundations of Creativity and Innovations, Creative thinking process, Types of Innovation: Incremental, Disruptive, and Radical, Innovation Process: from idea to execution; Protecting ideas - Patents and IPR. Exploring Technological Innovation through Case Studies.	
	Learning Outcome: *The learner would be able to* • *Use their understanding of the role Technological innovation plays in driving business success.* • *To formulate steps for taking an idea to product stage with necessary patents*	
3	**Ideation, Prototyping, Testing, Validation and Commercialisation**	5-6
	Learning Objectives: • *Experiment to test Minimum Viable Products (MVPs) and validate business ideas.* • *To formulate a Build-Measure-Learn feedback loop for continuous improvement.*	

	Contents: Identifying customer needs and problems to solve, Ideation, Concept Development, Design Thinking, Prototyping, Minimum Viable Product (MVP), Testing, and Iterations. Understanding the Market, customer feedback and refinement of business idea based on feedback. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Select specific measures to design, test, and validate Minimum Viable Products (MVPs) to assess business ideas.* • *Interpret the learnings from the build-measure-learn feedback loop to facilitate continuous improvement and learning.*	
4	**Financial Resources**	3-4
	Learning Objectives: • *Describe the key concepts, and strategies related to fundraising for entrepreneurial ventures.* • *Compare various funding sources, including angel investors, venture capitalists, grants, and crowdfunding platforms.* • *Devise and create compelling investor pitches, develop financial projections.*	
	Contents: Funding new ventures – bootstrapping, crowd sourcing, Angel investors, VCs, debt financing, and due diligence; Raising fund during life-cycle of a new ventures. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Recognize various fundraising strategies and techniques, enabling s to choose the most appropriate funding sources for their entrepreneurial ventures.* • *Sketch effective pitches and fundraising campaigns tailored to different types of investors and funding sources, ensuring successful capital-raising efforts.*	
5	**National Entrepreneurial Culture**	4-5
	Learning Objectives: • *To gain knowledge of legal and regulatory requirements for startups, including compliance with relevant regulations.* • *To identify the various government initiatives to develop the start-up ecosystem.*	
	Contents: Entrepreneurial Ecosystem in India, Key regulations and legal aspects, Forms of Business Ownership, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments,	

	banks etc. Government incentives for entrepreneurship, Incubation, & Acceleration.	
	Learning Outcome: *The learner would be able to* • *Describe the current scenario of Entrepreneurial activity in India.* • *To state legal and regulatory requirements and compliances for start-ups.* • *To state the various government initiatives to support the entrepreneurs.*	
6	**Start-up Case Studies**	3-4
	Learning Objectives*:* *To relate the real life case studies and analyse them for acquiring the clarity on various aspects of entrepreneurship covered in the first 5 modules*	
	Contents: Case Studies of various start-ups (with Indian Context): Start-ups from Tech, Edtech, Fintech, and Agriculture domain; Study of successful start-ups and failed start-ups.	
	Learning Outcome: • *To evaluate the real-world examples and case studies that will help them understand the practical aspects of idea to product, fundraising and financial management in the context of entrepreneurship.*	
7	***Course Conclusion***	1

In-semester Assessment - Continuous Assessment: Suggested

1 Teams of 3-4 students shall present a One-Minute business idea pitch– ideation phase-10 marks
2 Teams of 3-4 students shall present a Three-Minute Business Pitch –Validation phase-10 marks
3 Teams of 3-4 students shall present a Five-Minute Business Pitch for Funding- 15 marks
4 Teams of 3-4 students shall present analysis of one case study of successful or failed start-up- (15 Marks)

Course Outcome: Learner will be able to

CO1: State the concept of Entrepreneurship and Indian Start-up ecosystem
CO2: Identify the business ideas and to analyse the environment for potential business opportunity.
CO3: Identify the specific measures to design, test, and validate Minimum Viable Product.
CO4: State the key concepts, and strategies related to fundraising for entrepreneurial ventures.
CO4: Identify the legal and regulatory framework for entrepreneurs in Indian context.
CO5: Analyse and correlate the reasons for the success or the failure of entrepreneurial firms.

Text Books:

1. Poornima Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books

6. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
7. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.

Reference Books:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
3. India as Global Start-up Hub: Mission with Passion by C B Rao
4. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker
5. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich, Veland Ramadani, Springer (2017)
6. Entrepreneurship- Theory, Process Practice –by Kuratko &Hodgetts, Thompson South-Western Publication

Relevant Websites:

1. www.msme.gov.in
2. www.dcmesme.gov.in
3. www.msmetraining.gov.in

Other Resources:

1. NPTEL Course: Entrepreneurship By Prof. C Bhaktavatsala Rao, IIT Madrao
   Weblink https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. NPTEL Course: Entrepreneurship Essentials By Prof. Manoj Kumar Mondal, IIT Kharagpur
   Weblink https://onlinecourses.nptel.ac.in/noc21_ge06/preview

Course Type	Course Code	Course Name	Credits
PCC	ECPCC611	DISCRETE TIME SIGNAL PROCESSING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC509 Signals and Systems

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design / Development of Solutions
4. PO5 : Engineering Tool Usage
5. PO6 : Engineer and World
6. PO11: Life long Learning

Course Objectives:

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To guide the students to design and realize IIR filters and FIR filters, gain an appreciation for the trade-offs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce the need and concept of multirate signal signal processing and its applications

Module	Details	Hrs.
	Course Introduction : Block diagram of Digital Signal Processing System, Advantages of signal processing in digital domain Discrete-Time Signal Processing (DSP) is at the core of modern technological systems where digital signal manipulation is essential. From telecommunications and control systems to biomedical devices and multimedia, DSP enables the efficient analysis and transformation of signals. This course explores critical DSP techniques, including the Discrete Fourier Transform (DFT) and its fast implementation using the Fast Fourier Transform (FFT), essential for spectral analysis and filtering in real-time applications. Students will delve into digital filter design, realization structures, and the challenges posed by finite word length effects, which impact precision in hardware implementations. The course also covers multirate signal processing, essential for efficient data compression and system performance optimization in advanced communication and signal processing systems. Through rigorous analysis and practical exercises, students	**01**

	will gain the skills necessary to design and implement sophisticated DSP algorithms in real-world scenarios.	
01.	**Discrete Fourier Transform** ***Learning Objective:*** 1. *To introduce the concept and applications of circular convolution and relate it to linear convolution* 2. *To educate the students about the need, mathematical formulation and efficient implementation of DFT in spectral Analysis of signals* **Contents:** Definition and Properties of DFT, IDFT, Circular convolution of sequences using DFT and IDFT. Filtering of long data sequences: Overlap-Save and Overlap-Add Method for computation of DFT. Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT ***Self-Learning Topics:*** *Goertzel Algorithm, Chirp-Z Algorithm, Split Radix FFT* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply the properties of DFT to efficiently represent the given signal in the frequency domain (PI 1.1.2)* *LO 1.2 : Perform linear filtering of long data sequences using DFT (PI 1.4.1)*	**7-9**
02.	**IIR Digital Filters** ***Learning Objective:*** 1. *To introduce the concept of analog and digital frequencies along with their mapping.* 2. *To guide the students to transform the given data into design specifications and design appropriate IIR filter.* **Contents:** Analog and Digital filter specification, Frequency normalization Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations ***Self-Learning Topics: --*** ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply mathematical techniques for mapping the analog transfer function to digital domain. (PI. 2.4.1)* *LO 2.2 Identify system variables for designing an appropriate filter for the given specifications (PI 2.1.2)* *LO 2.3 Extract specifications of the digital filter from the given data and design an IIR appropriate filter for given real world signal. (PI 3.1.6) (PI 6.1.1)* *LO 2.4 Identify relevant data from the given resources and implement the proposed solution for given case study using appropriate tools (PI 3.3.3), (PI 5.2.2)*	6-8

03.	FIR Digital Filters ***Learning Objectives:*** 1. *To introduce the concept and significance of linear phase in digital filters* 2. *To educate the students about types and design of linear phase FIR filters* 3. *To guide the students to design FIR filters using windowing method and compare the performance for different types of windows*	**5-7**
	Contents: Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackmann, Bartlett), Design of FIR filters using Frequency Sampling Technique – Type I low pass filter design, Comparison of IIR and FIR filters	
	Self-Learning Topics: *Kaiser Window, Hilbert Transform, Frequency Sampling method, Optimum Equiripple filter design.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Analyze the frequency domain behavior of Linear phase FIR filters (PI 2.1.3)* *LO 3.2 : Design Linear Phase FIR filters for the given constraints (PI 3.1.6)* *LO 3.3: Apply Windowing concepts for obtaining optimal design solution for the given specification pertaining to a real world scenario.(PI 3.3.3) (PI 6.1.1)* *LO 3.4: Identify relevant data from the given resources and implement the proposed solution for given case study using modern tool (PI 3.3.3), (PI 5.2.2)(PI 11.1.3)*	
04.	**Digital Filter Structures** ***Learning Objectives:*** ***1.*** *To educate the students about different Realization of digital filters and gain an appreciation for the tradeoffs necessary in the filter design.*	
	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter.	
	Self-Learning Topics: *Frequency Sampling structure*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Implementation of the designed filter using suitable Realization techniques (PI 2.3.2)* *LO 4.2 : Evaluate the impact of realization structure on computational complexity and hardware implementation (PI 2.4.4)*	
05.	**Finite Word Length Effects in Digital Filters** ***Learning Objective/s:*** 1. *To introduce the different sources of error in a digital signal processing system.* 2. *To educate the students about the effects of hardware limitation on the efficiency and stability of the designed filter.*	**5-7**

	Contents: Rounding and truncation errors, Quantization error, Effect of Product quantization on pole / zero locations, Noise model for direct form and cascaded IIR structure (first order) and zero input limit cycle.	
	Self-Learning Topics: --	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify and describe the sources of error in a digital signal processing system (PI 2.4.3)* *LO 5.2: Model quantization error and analyse its impact on the system performance. (PI 2.3.2)*	
06.	**Basics of Multirate Signal Processing**	**7-9**
	Learning Objective/s: 1. *To explain the difficulties associated fixed sampling rate systems and hence emphasize on the need of multirate systems.* 2. *To introduce the students to concept of decimation and interpolation and their relevance in filter banks*	
	Contents: Decimation by a factor D, interpolation by I, sampling rate conversion by a rational factor I/D Polyphase filter structures for decimation and interpolation filters, Design of Multistage implementation of sampling rate conversion (using elliptical filters) Two band filter bank	
	Self-Learning Topics: *Dyadic wavelet filter banks*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Analyse decimators and interpolators in the context of multirate system and filter banks.(PI 2.4.2), (PI 2.4.4)* *LO 6.2: Design Multirate systems for given sampling rate conversion factor using filter design techniques. (PI 3.1.6)* *LO 6.3: Efficiently model the given system using Polyphase structure. (PI 3.2.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.2	Apply mathematical transforms to solve problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.1	Apply formal idea generation tools to build models/prototypes in order to develop multiple engineering design solutions.
3.3.3	Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.1.1	Identify environmental and health issues related to engineering profession with the help of relevant viewpoints from stakeholders and propose solutions.

Course Outcomes: A learner will be able to -

1. Analyze signals and systems using Discrete Fourier transform and employ DFT for linear filtering of long data sequences. *(LO 1.1, LO 1.2)*
2. Design and realize Butterworth, Chebyshev IIR filters and other frequency selective filters to satisfy the given specifications. .*(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 4.1, LO 4.2)*
3. Characterize, design, and implement FIR filters while analysing their frequency response and performance.*(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2)*
4. Analyze the effect of hardware limitations on performance of digital filters.*(LO 5.1, LO 5.2)*
5. Design and efficiently implement Multirate digital filters for the given specification. *(LO 6.1, LO 6.2, LO 6.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPCC611.1	3										
ECPCC611.2		3	3		2	2					2
ECPCC611.3		3	3		2	2					2
ECPCC611.4		3									
ECPCC611.5		3	3								
Average	3	3	3		2	2					

Text Books :

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference Books :

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th Edition McGraw Hill Education (India) Private Limited.
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education
3. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited.
4. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2006.
5. Monson H Hayes, "Digital Signal Processing",Schaum's Outline Series, Mc Graw Hill Limited.

Other Resources :

1. Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
   http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2. Course: Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
   https://nptel.ac.in/courses/108/101/108101174/
3. Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105055/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Class test: 05 Marks
b) Design Assignment: 05 Marks
c) Case study: Design and Software Implementation, Analysis: 05 Marks
d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage

Course Type	Course Code	Course Name	Credits
PEC	ECPEC6021	RANDOM SIGNAL ANALYSIS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC405 - Engineering Mathematics-IV
2. ECPCC509 - Signals and Systems

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design / Development of Solutions
4. PO5: Engineering Tool Uses
5. PO11: Life-long learning

Course Objectives:

1. To impart a thorough understanding of fundamental principles of probability and conditional probability, and guide students in applying Bayes' theorem to various contexts such as communication systems and medical test evaluations.

2. Teach students to comprehend and compute probability density functions (pdf), cumulative distribution functions (CDF), and probability mass functions (PMF), and explore various distributions including Poisson, uniform, Gaussian, and Rayleigh distributions to solve engineering problems.

3. To explain the concepts of bivariate random variables and their joint distributions, teach students how to compute joint pdfs and PMFs, and guide them in analyzing conditional distributions, covariance, and correlation coefficients.

4. To help students solve problems involving the transformation of random variables, and teach them how to compute mean, variance, moments, and characteristic functions of transformed variables, emphasizing their significance in practical applications.

5. To guide students in analyzing the temporal and spectral characteristics of random processes, including stationary processes, Poisson and Gaussian processes, and the relationship between power spectral density and autocorrelation functions.

6. To impart an understanding of the principles of maximum likelihood estimation, logistic regression, Gaussian Mixture Models, and the Expectation-Maximization algorithm and applications of Bayes' theorem, MAP estimation, and the Naïve Bayes classifier to machine learning problems.

7. To assign case studies/simulations/projects that shall explicitly link key RSA topics to their relevance in Signal Processing/Telecommunication/AIDL.

Module	Details	Hours
	Course Introduction The Random Signal Analysis (RSA) course is crucial for students in electronics and telecommunication engineering, offering essential tools to analyze and interpret random processes in practical applications. It provides a solid grounding in probability theory, random variables, and random processes, enabling students to tackle uncertainties in communication systems and signal processing effectively. This knowledge is directly applicable in fields like machine learning, where understanding and modelling randomness is key to developing robust algorithms and systems. By mastering RSA concepts, students can enhance the reliability and performance of modern telecommunication networks and contribute to advancements in machine learning applications, making them well-prepared for both academic and industry challenges.	**01**
01.	**Probability Theory** ***Learning Objective/s:*** 1. *Teach the concept of random signals, uncertainty and its implications in engineering and machine learning.* 2. *Instruct students on the mathematical models with probability and random processes.* 3. *Educate students on Bayes' theorem and guide them in applying it to various contexts such as binary communication channels, medical test evaluations, etc.* **Contents:** 1.1 Random signals and uncertainty - Uncertainty in day-to-day life, in engineering, and in machine learning. 1.2 Mathematical models – Modelling with probability, with random variables, and with random processes. 1.3 Bayes' theorem and its application in binary communication channels, in the evaluation of medical tests, etc. ***Self-Learning Topics:*** *1. To assign relevant class assignments as a part of continuous assessment.* *2. Engineering Application: Optical Communication System (Refer to Section 2.8 from the Miller and Childers reference book at serial number 1 below).* ***Learning Outcomes:*** *A learner will be able to* *LO1.1 Identify constraints of uncertainty in day-to-day life, engineering, and machine learning. (PI: 2.1.1)* *LO1.2 Apply mathematical modelling in probability and Bayes' theorem to solve problems related to binary communication channels, medical test evaluations, etc. (PI: 1.1.3)*	**06-08**
02.	**Random Variables** ***Learning Objective/s:*** 1. *Teach the concepts of a histogram for given data samples and its relation with probability density function (pdf), cumulative distribution function (CDF), and probability mass function (PMF).*	**06-08**

	2. Educate students on various probability distributions and conditional distributions, their simulation, and their statistical parameters for Poisson, uniform, Gaussian, and Rayleigh distributions, and explain the concept of the central limit theorem.	
	Contents:	
	2.1 Histogram of given random data samples, probability density function (pdf), cumulative distribution function (CDF), and probability mass function (PMF). 2.2 Examples and simulation of Poisson distribution, uniform distribution, Gaussian distribution and central limit theorem, and Rayleigh distribution for specific applications; Their statistical parameters (mean and variance). 2.3 Conditional distributions.	
	Self-Learning Topics:	
	1. To assign relevant case studies/simulations/projects as a part of continuous assessment. *2. Engineering Application*: *Reliability and failure rates (Refer to Section 3.6 from the Miller and Childers reference book at serial number 1 below).*	
	Learning Outcomes :	
	A learner will be able to *LO2.1 Formulate mathematical models for random variables and analyze histograms, probability density functions (pdf), cumulative distribution functions (CDF), and probability mass functions (PMF) to understand random data samples. (PI: 2.3.1)* *LO2.2 Solve numerical related to mean, variance, and conditional distributions of various probability distributions such as Poisson, uniform, Gaussian, and Rayleigh distributions. (PI: 2.4.1)* *LO2.3 Identify suitable modern tools and simulate the above distributions for specific applications. (PI: 5.1.1)*	
03.	**Multiple Random Variables**	**07-09**
	Learning Objective/s:	
	1. Teach the concepts of bivariate random variables and their joint CDF, pdf, and PMF, conditional means and conditional variances, conditional distributions, covariance, and correlation coefficients.	
	Contents: 3.1 Bivariate random variables (BRVs) - Joint distribution functions, joint pdf, joint PMF and corresponding marginal probability functions; Independent BRVs. 3.2 Conditional distributions, covariance, and correlation coefficient. 3.3 Conditional means and conditional variances.	
	Self-Learning Topics:	
	1. To assign relevant class assignments as a part of continuous assessment *2. Engineering Application*: *Refer to the University of Texas document on 'Random Variables and Applications' available at*: *https://www.utdallas.edu/~scniu/OPRE-6301/documents/Random_Variables_Applications.pdf*	
	Learning Outcomes :	
	A learner will be able to *LO3.1 Apply the concepts of bivariate random variables, joint distribution functions, joint probability density functions (pdf), and joint probability mass functions (PMF) to solve relevant numerical. (PI: 1.1.1)* *LO3.2 Calculate conditional distributions, covariance, and correlation coefficients to*	

	analyze relationships between multiple random variables. (PI: 1.1.1)	
04.	**Functions of Random Variables**	**05-07**
	Learning Objective/s:	
	1. Teach the basic concepts of functions of random variables and their significance, Moment Generating Function (MGF) and characteristic function, and solve relevant numerical problems.	
	Contents:	
	4.1 Introduction to functions of random variables; Solving problems of the type $Y = g(X)$ and $Z=g(X, Y)$ (e.g., $\boldsymbol{Y = aX + b, Y = X^2, Z = X + Y, Z = XY, Z = X/Y}$ etc.), and transformation of two input RVs to two output RVs. 4.3 MGF and characteristic functions.	
	Self-Learning Topics:	
	1. To assign relevant class assignments as a part of continuous assessment *2. Engineering Application*: *Refer to the Indiana University document on Functions of RVs: https://pdesign.sitehost.iu.edu/me360/ch5.pdf.*	
	Learning Outcomes:	
	A learner will be able to *LO4.1 Apply mathematical techniques to solve problems involving functions of random variables. (PI: 1.1.1)* *LO4.2 Solve numerical related to MGF and characteristic functions. (PI: 2.4.1)*	
05.	**Random Processes**	**06-08**
	Learning Objective/s:	
	1. Teach the temporal characteristics of random processes and the concepts of stationary processes (Strict Sense Stationary (SSS) and Wide Sense Stationary (WSS), time averages, and ergodicity. *2. Educate students on the Poisson process and the Gaussian process.* *3. Explain the spectral characteristics of random processes, including the relationship between power spectral density (PSD) and autocorrelation function (ACF), white noise, and transmission through LTI systems.*	
	Contents:	
	5.1 Temporal Characteristics: Classification of random processes, joint density function, mean and autocorrelation, SSS, WSS, time averages and ergodicity, Poisson process, Gaussian process. 5.2 Spectral Characteristics: Relation between PSD and ACF, white noise, transmission of WSS through the LTI system.	
	Self-Learning Topics:	
	1. To assign relevant case studies/class assignments as a part of continuous assessment *2. Applications of Random Processes.* *(i) https://www.linkedin.com/pulse/applications-random-process-electronic-communication-geetha-muthu* *(ii) https://www.techniques-ingenieur.fr/en/resources/article/ti383/random-processes-foundations-and-applications-te5222/v1*	
	Learning Outcomes:	

	A learner will be able to *LO5.1 Classify given random processes into WSS/SSS/Ergodic. (PI: 2.4.1)* *LO5.2 Evaluate the spectral characteristics of transmission of the WSS process through the LTI system. (PI: 2.3.1)*	
06.	**Maximum Likelihood and Bayesian Probability**	**07-09**
	Learning Objective/s: 1. *Teach the principles of maximum likelihood estimation and its applications in machine learning, and logistic regression as an example of maximum likelihood estimation.* 2. *Instruct students on the Gaussian Mixture Model (GMM) and the Expectation-Maximization (EM) algorithm, Bayes' theorem and its applications in machine learning, including Maximum A Posteriori (MAP) estimation and the Naïve Bayes classifier.* 3. *Make the students identify problems relevant to the above-stated learning objectives through self-directed learning.*	
	Contents: 6.1 Maximum likelihood estimation, relationship to machine learning, logistic regression as maximum likelihood, GMM and EM algorithm and their relevance in solving practical problems. 6.2 Bayes' theorem, MAP, and machine learning, Naïve Bayes classifier and their relevance in solving practical problems.	
	Self-Learning Topics: 1. *To assign relevant case studies/simulations/projects as a part of continuous assessment* 2. *https://www.datasciencecentral.com/understanding-the-applications-of-probability-in-machine-learning/* 3. *https://www.tableau.com/learn/articles/machine-learning-examples* 4. *https://www.cs.toronto.edu/~urtasun/courses/CSC411_Fall16/tutorial1.pdf* 5. *https://ieeexplore.ieee.org/iel7/79/9127839/09127856.pdf*	
	Learning Outcomes: *A learner will be able to* *LO6.1 Apply maximum likelihood estimation to model parameters in engineering problems. (PI: 2.4.1)* *LO6.2 Utilize Bayesian probability theory to make informed decisions in engineering applications, integrating concepts of MAP and Naïve Bayes classifiers for problem-solving. (PI: 1.1.3)* *LO6.3 Critically evaluate current research trends in machine learning applications of maximum likelihood and Bayesian methods, demonstrating the ability to access and synthesize information from technical literature. (PI: 11.3.1)(PI: 3.1.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, probability and statistics, and Boolean algebra to solve problems.

1.1.3 Apply advanced mathematical techniques of electronics and telecommunication or computer and information science to describe/solve/construct a mathematical model of a system.

2.1.1 Articulate problem statements and identify primary objectives and key constraints.

2.3.1 Combine scientific principles and engineering concepts to formulate a model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.

2.4.1 Apply engineering mathematics and computations to solve mathematical models.

3.1.1 Recognize that need analysis is key to good problem definition.

5.1.1 Identify modern hardware and software engineering tools, techniques and resources for engineering activities.

11.3.1 Identify sources and comprehend information from technical literature and other credible sources of information.

Course Outcomes:

Students will be able to

1. Apply fundamental principles of probability theory and advanced mathematics to model, solve, analyse, and simulate problems related to uncertainty, Bayes' theorem, random variables, multiple random variables, and functions of random variables. (*LO1.1, LO1.2, LO2.2, LO2.3, LO3.1, LO3.2, and LO4.1*)

2. Analyze and simulate uncertainty in mathematical modelling of random variables, histograms of density functions, moment-generating functions, and characteristic functions. (*LO2.1, LO2.3, and LO4.2*)

3. Analyze the mathematical models of systems representing temporal and spectral characteristics of random processes, and apply this understanding to solve the problems. *(LO5.1 and LO5.2)*

4. Apply fundamental principles of probability theory and advanced mathematics to solve and analyse problems related to machine learning algorithms. (*LO6.1 and LO6.2*)

5. Identify relevant problems in modelling machine learning applications and present appropriate solutions by applying maximum likelihood and Bayesian methods. (*LO6.1, LO6.2, and LO6.3*)

CO-PO Mapping Table with Correlation Level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPEC6021.1	3	3	-	-	2	-	-	-	-	-	-
ECPEC6021.2	3	3	-	-	2	-	-	-	-	-	-
ECPEC6021.3	3	3	-	-	-	-	-	-	-	-	-
ECPEC6021.4	3	3	-	-	-	-	-	-	-	-	-
ECPEC6021.5	3	3	3	-	-	-	-	-	-	-	2
Average	3	3	3	-	2	-	-	-	-	-	2

Text Books:

1. A. Papoulis and S. U. Pillai, *Probability, Random Variables, and Stochastic Processes*. Tata McGraw Hill Education.
2. H. Stark and J. W. Woods, *Probability, Statistics, and Random Processes for Engineers*, 4th ed. Pearson Education, 2012.
3. P. R. Babu, *Probability Theory and Random Process*. Tata McGraw Hill Education.

4. T. Veerarajan, *Probability, Statistics and Random Process*, 3rd ed. Tata McGraw Hill Education, 2018.
5. J. Brownlee, *Probability for Machine Learning*, (e-Book). Copyright 2020 Jason Brownlee.

Reference Books:

1. S. Miller and D. Childers, *Probability and Random Processes with Applications to Signal Processing and Communications*. Elsevier (2004).
2. H. Hsu, Theory and Problems of Probability, Random Variables, and Random Processes, Schaum's Outline Series. McGraw Hill, 1997.
3. A. L. Garcia, *Probability and Random Processes for Electrical Engineering*, 2nd ed. Pearson Education.
4. R. E. Walpole et al., Probability and Statistics for Engineers and Scientists, 8th ed. Pearson Education.
5. D. Witten, T. Hastie, and R. Tibshirani, An Introduction to Statistical Learning, 7th ed. Springer, 2017.
6. P. Kousalya, *Probability, Statistics, and Random Processes*. Pearson Education.
7. D. C. Montgomery, E. A. Peck, and G. G. Vining, *Introduction to Linear Regression Analysis*, student ed. Wiley.

Other Resources :

1. Introduction to probability and Statistics, Prof. G. Srinivasan (IIT Madras); https://onlinecourses.nptel.ac.in/noc21_ma01/preview
2. Probability and Probability Distributions By Dr. P.Nagesh: https://onlinecourses.swayam2.ac.in/cec21_ma02/preview
3. Khan Academy - Statistics and Probability: https://www.khanacademy.org/math/statistics-probability/random-variables-stats-library
4. MIT OpenCourseWare: https://ocw.mit.edu/courses/6-011-signals-systems-and-inference-spring-2018/pages/lecture-slides/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Case studies and/or Simulations and/or Projects and/or Class Assignments which will map the concepts in this course to AIML: 10 Marks

c) Flip classroom: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ECPEC6022	OPTICAL FIBER COMMUNICATION	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ECPCC407 Principles of Communication
2. ECPCC510 Digital Communication
3. BSC102 Engineering Physics-I

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO 3: Design/Development of Solution
4. PO5: Modern tool usage
5. PO 8: Individual and teamwork
6. PO 9: Communication
7. PO 11: Life-long learning

Course Objectives:

1. To familiarize with basic concepts and theory to understand signal propagation through optical fiber.
2. To convey the channel impairments like losses and dispersion, and determine transmission losses in optical fiber.
3. To convey different modulation techniques.
4. To explain link budget using given data.
5. To develop an understanding related to different optical parameter measurements techniques.
6. To familiarize with different optical networks and its management.

Module	Details	Hrs.
	Course Introduction Optical communication is a technology that uses light to transmit information over distances. This course will help students to learn historical development of optical communication. This course will help students to learn basic of optical communication, working of sources and detectors, different components and optical networks.	**01**

	As technology evolves, there's a growing need for efficient communication systems with fast and reliable data transmission. Knowledge of optical communication is crucial for designing and implementing the infrastructure needed for high-speed internet and telecommunications. The telecommunications and networking sectors require skilled professionals in optical communication, providing ample career opportunities.	
01.	**Introduction to optical fibers communication** ***Learning Objective:*** ***1.*** *Familiarize students with need for optical fiber communication* ***2.*** *Convey basics related to optical fiber communication* ***3.*** *Describe MCVD technique for high quality fiber* ***4.*** *Convey basics of Photonic Crystal Fiber*	
	Contents: Optical Bands and Windows, Need for optical fiber communication, Fiber optic cable types and color codes, advantages and disadvantages of optical fiber cables, Applications Basics of Optical Fiber: Review of Ray theory, Light propagation in optical fiber Classification of optical fibers based on number of propagating modes, refractive index profile, fiber material used, Propagation modes Concept of mode field diameter in single mode fiber Fiber material, Fabrication techniques for high quality fiber: Modified Chemical Vapor Deposition method Fiber joints, fiber connectors, splices. Brief introduction to Photonic Crystal Fiber and its types.	**07**
	Self-Learning Topics: Mechanical properties of fiber	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply concepts of optical communication such as number of modes, RI profile, material used for fabrication and color code to classify fibers. (PI.1.4.1)* *LO 1.2: Identify the types of fiber which suits to requirement of particular application. (PI.2.1.2)* *LO 1.3: Breakdown MCVD fabrication technique into interconnected sub systems and analyze the working of it. (PI. 2.2.1)* *LO 1.4: Identify the method / component such as fiber joint, fiber connector, splice which can be used for joining fibers depending on the requirement of optical fiber communication system. (PI. 2.1.3)* *LO 1.5: Summarize photonic crystal fibers which are used in optical fiber communication system to transmit high optical power. (PI 1.3.1)* *LO 1.6: Determine transmission parameters for optical fiber using Ray theory and arrive at specifications. (PI. 3.1.6)* *LO 1.7: Identify given data such as numerical aperture, critical angle, acceptance angle and arrive at best propagation mode for a given signal.(PI 3.3.3)*	
02.	**Transmission Characteristic of Optical Fiber**	**07**

	Learning Objective: 1. *Develop understanding of dispersion in Optical fiber through basic concepts.* 2. *Familiarize students with different transmission losses in the optical fiber communication.* 3. *Convey concept of attenuation in Optical fiber.*	
	Contents: Signal degradation in optical fibers: Attenuation, Absorption losses- Intrinsic and Extrinsic absorption, Scattering losses- Linear and nonlinear scattering losses, Bending losses Signal distortion in fiber: Dispersion-Intermodal and Intramodal Dispersion, Need for dispersion management, Dispersion compensation techniques Specialty Fibers: Erbium doped fiber, Photosensitive Sensitive fiber, Bend-insensitive fiber, Polarization preserving fiber	
	Self-Learning Topics: Polarization, Solitons	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply concepts of attenuation, dispersion etc. to determine their value. (PI 1.4.1)* *LO 2.2: Identify the type of dispersion and apply relevant knowledge to solve a given problem. (PI. 2.1.2)* *LO 2.3: Apply fundamental concepts to estimate losses in fiber. (PI 1.3.1)* *LO 2.4: Identify appropriate method for reducing effect of dispersion in optical fiber system. (2.2.3)* *LO 2.5: Apply concepts of optical fiber communication to summarize different types of specialty fibers. (PI 1.4.1)* *LO 2.6: Develop ability to learn independently through hands-on activity based on parameters measurement, analysis of losses and present result effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI. 11.1.2, PI. 11.1.3)*	
03.	**Optical Communication Sources and detectors, and Modulation techniques**	**08**
	Learning Objective: ***1.*** *Develop understanding related to working principle and characteristics of sources and detectors* *2. Familiarize students with different modulation schemes in the optical fiber communication.*	
	Contents: Block diagram of optical fiber communication system Optical Sources- LED: Edge emitter led LASER- Vertical cavity surface emitting laser Optical detectors: Photodetector, p-i-n photodiode, Avalanche photodiode Concept of Quantum efficiency, Responsivity	

	Modulation schemes used in optical communication- On Off Keying, Phase shift keying	
	Self-Learning Topics: ***Double hetrojunction Led, Surface emitter led, Distributed feedback laser***	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Breakdown the entire optical fiber communication system into interconnected sub systems and analyze the working of it. (PI. 2.2.1)* *LO 3.2: Compare different sources as well as detectors used in optical fiber communication with their working principle and characteristics to select the best according to requirement. (PI. 2.2.4)* *LO 3.3: Determine different parameters such as efficiency, responsivity related to optical sources/detectors and arrive at specifications. (PI. 3.1.6)* *LO 3.4: Identify parameters applicable to different modulation schemes used in optical communication and also differentiate these techniques by applying respective knowledge. (PI 2.1.2)* *LO 3.5: Identify the given data such as frequency, bit rate and arrive at best modulation scheme for a given condition.(PI 3.3.3).*	
04.	**Optical amplifier and receiver** ***Learning Objectives:*** 1. *Familiarize students with different types of optical amplifiers with their working principle* *2. Convey working of optical receivers.* *3. Summarize concept of Bit error rate, Q function.* *4. Understand a link budget.*	**08**
	Contents: Optical amplifier- Erbium doped fiber amplifier, Raman amplifier, Semiconductor optical amplifier Noise figure and signal to noise ratio in optical amplifier Optical receivers: Block diagram, types of noise in receiver Receiver performance parameters: Bit error rate, Q function Coherent detection, Intensity modulation Point to point links system considerations, link power budget, and rise time budget	
	Self-Learning Topics: Wideband Optical amplifier	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply concepts of amplification to summarize working of optical amplifiers with principle. (PI. 1.4.1).* *LO 4.2: Breakdown the entire optical fiber communication system into interconnected sub systems to determine losses or delay incorporated by each block and illustrate the entire link budget. (PI. 2.2.1)* *LO 4.3: Apply concepts of coherence and direct detection to determine signal parameters through mathematical analysis. (PI 2.1.2)* *LO 4.4: Develop ability to learn independently through hands-on activity based on working of optical amplifier and present result effectively. (PI 1.3.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI. 11.1.2, PI. 11.1.3)*	

05.	**Performance measurement and monitoring** ***Learning Objective/s:*** *1. Understand a need to perform optical parameter measurement.* *2. Understand different optical parameter measurement procedure.* *3. List and understand different test equipments used in optical communication system.*	**06**
	Contents: Measurements: Optical power measurement, Attenuation measurement, Dispersion measurement, Eye diagram tests, Optical Signal to noise ratio monitoring Test equipments: Test support lasers, Optical spectrum analyzer, Visual fault indicator, Conformance analyzer, Optical Time Domain Reflectometer	
	Self-Learning Topics: Fiber refractive index profile measurement, Numerical aperture measurement	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify an appropriate test equipment for particular parameter measurement in optical communication system. (PI. 5.1.1)* *LO 5.2: Use an appropriate measurement method to measure particular parameter such as power, attenuation to solve a given problem. (PI. 5.1.2)* *LO 5.3: Develop ability to learn independently through hands-on activity based on parameters measurement and present result effectively. (PI 1.3.1, PI 1.4.1, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI. 11.1.2, PI. 11.1.3)*	
06.	**Optical Networks and management** ***Learning Objective/s:*** *1. Understand need of different optical network system components.* *2. Differentiate SONET and SDH techniques.* *3.List and understand different network management functions.*	**07**
	Contents: Components: Couplers, Isolators , Circulators, Fiber gratings filters, Add drop multiplexers, switches, Variable optical attenuator, Optical amplifier Network: SONET (Synchronous Optical Network) and SDH (Synchronous Digital Hierarchy) standards, Protection schemes in SONET/SDH Types of WDM (Wavelength Division Multiplexing) Networks WDM Long Haul Networks Network management functions, configuration management, performance management, fault management	
	Self-Learning Topics: Data center networks and Elastic Networks, Optical Burst switching Networks, Software Defined Network	
	Learning Outcomes:	

	A learner will be able to *LO 6.1: Apply concepts of networking to summarize different optical network system components and different networks. (PI. 1.4.1)* *LO 6.2: Identify direction/s of signal propagation, number of modes, types of protection links to solve a given network problem. (PI. 2.1.2)* *LO 6.3: Compare different types of networks on the basis of bit rate, data transmission principle to select the appropriate transmission method/network. (PI 2.2.4)* *LO 6.4: Apply knowledge of network management functions to solve given problem. ((PI. 1.3.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.1	Breakdown complex problem into interconnected sub systems and analyse by proper assumptions/ justification from information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solutions to select the best methodology.
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.3.3	Identify relevant data from the given resources and arrive at a best fitting design solution for particular specifications.
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.1.2	Use/adapt/modify/create tools and techniques to solve engineering problems
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
9.1.1	Read, understand and interpret technical and/or non-technical information.
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others.
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. Apply basic concepts and theory to understand signal propagation through optical fiber. *(LO 1.1 to LO 1.7)*
2. Summarize the channel impairments like losses and dispersion, and determine transmission losses in optical fiber. *(LO 2.1 to LO 2.6)*
3. Classify the Optical sources as well as detectors with their working principle and characteristics, and analyse the working of receiver in optical communication system. *(LO 3.1 to 3.5)*

4. Design power and rise time budget for a given set of optical fiber system parameter. *(LO 4.1 to LO 4.4)*
5. Select an appropriate device for a particular parameter under measurement. *(LO 5.1 to LO 5.3)*
6. Comprehend different optical networks and its management. *(LO 6.1 to LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPE6022.1	3	3	3								
ECPE6022.2	3	3						3	3		3
ECPE6022.3		3	3								
ECPE6022.4	3	3	3					3	3		3
ECPE6022.5					3						
ECPE6022.6	3	3									
Average	3	3	3		3			3	3		3

Text Books :

1. John M. Senior Optical Fiber Communication, 3rd Edition, 2013
2. Gerd Keiser, Optical Fiber Communication, 4th Edition, 2012
3. T.L.Singhal Optical Fiber Communication Principles and Applications, Cambridge Press, Edition 2016

Reference Books :

1. G Agarwal Fiber optic communication Systems
2. Biswanath Mukherjee, ―Optical Communication Networks‖, McGraw-Hill, 1997
3. Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perespective‖, Elsevier Publication Elsevier India Pvt.ltd, 3rd Edition, 2010
4. P.E.Green, ―Optical Networks‖, Prentice Hall,1994

Other Resources :

1. Fiber Optic Communication Technology- Deepa Venkitesh, Department of Electrical Engineering, IIT Madras
. **https://www.youtube.com/playlist?list=PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqYl**
2. Semiconductor Optoelectronics by Prof. M.R.Shenoy, Department of Physics, IIT Delhi **https://www.youtube.com/playlist?list=PLbMVogVj5nJSvhvgcBfT3e6HFFuhq2xqz**

IN-SEMESTER ASSESSMENT (75 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. Class test: 5 marks
2. Hands-on assignment: 10 marks
3. Regularity and active participation: 5 marks

2.Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ECPEC6023	ANALOG VLSI	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESC 102 Basic Electrical Engineering
2. ESC 203 Basic Electronics
3. ECPCC302 Network Theory
4. ECPCC303 Electronics Devices and Circuits
5. ECPCC406 Linear Integrated Circuits
6. ECPEC5013 Digital VLSI

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design / Development of Solutions
4. PO5: Modern tool usage

Course Objectives:

1 To learn the basics of CMOS Analog design in the field of Electronics and Telecommunication.

2 To familiarise the methodologies for analysis and design of fundamental CMOS Analog circuits like Basic Building Blocks of Analog Design, Single stage Amplifiers, Analog Sub Circuits and Bandgap reference.

Module	Details	Hrs.
	Course Introduction This course is personalized to provide with a comprehensive essential principles and techniques involved in designing analog electronic circuits in an integrated circuit using MOS transistors which is foundational for modern electronic systems. As we delve into the details of analog design, we will gain valuable insights into the principles, methodologies, and tools that drive the creation of integrated circuits which is need of the hour.	**01**
01.	**Fundamentals Analog Building blocks** ***Learning Objective/s:***	

	1. *To familiarize the basics of MOS Transistor on the basis of small signal and large signal model.* **2.** *To provide competence in engineering fundamentals to recognize the concepts of basic building blocks and basic cells.*	
	Contents: Introduction to Analog VLSI Circuits Design, Design Flow of Analog VLSI Circuits. Second order effects, MOS small signal model, MOS capacitances, body bias effect, Current biasing, voltage biasing, technology biasing, relative comparison and limitations. Basic building blocks and basic cells – Switches, active resistors, current sources and sinks, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to realize the second order effects, current source, sink and comparison of different biasing. (P.I.-1.3.1)* *LO 1.2: **Apply** body bias techniques to modify threshold voltages in a given scenario. (P.I.-1.4.1)* *LO 1.3: Identify and analyze the circuit implementation of each biasing methods (current, voltage and technology), compare and arrive to the limitations if any for a given problem. (P.I.-2.1.3)* *LO 1.4: Compare and contrast alternative solutions to select the best methodology on active and passive current mirrors. (P.I-2.2.4)*	
02.	**Analog CMOS Sub Circuits** ***Learning Objective:*** 1. *To provide proficiency of different switched capacitor circuits with the help of simulation software.*	
	Contents: Switched Capacitor circuits - basic principles, sampling switches, switched capacitor integrator, switched capacitor amplifier Simulation of CMOS sub circuits using SPICE.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental engineering concepits on clock phases, non-overlapping clocks, charge injection and clock feedthrough effects. (P.I-1.3.1)* *LO 2.2: Apply fundamental engineering concepts to solve Switched Capacitor circuits (P.I-1.4.1)* *LO 2.3: Compare switched capacitor circuits with traditional resistor-based designs in terms of performance and area. (P.I.- 2.2.4).* *LO 2.4: Identify the mathematical, engineering and other relevant knowledge that applies to switched capacitor integrator and amplifier circuits. (P.I-2.1.3)*	
03.	**CMOS Single Phase Amplifiers**	

	Learning Objective: ***1. To provide the ability to design & analyze MOS based Analog VLSI Circuits***	
	Analytical justification of operating region suitable for amplification/switching and limitations, design of Common-Source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascode stage with parasitics. Frequency responses of CS stage, CD stage, CG stage, cascode stage, simulation of CMOS amplifiers using SPICE.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply fundamental engineering concepts to solve engineering problems on basic operating region suitable for particular application. (P.I-1.3.1).* *LO 3.2: Apply core principles to classify different CMOS amplifier topologies (P.I-1.4.1)* *LO 3.3: Identify the mathematical approach that applies to different CMOS amplifier topologies for a given specification. (P.I-2.1.3).* *LO3.4: Identify the sources of error in topologies, analyze with frequency responses and their limitations. (P.I-2.4.3)* *LO 3.5: Develop an ability to learn different CMOS amplifier topologies for given specification using open source software. (P.I.- 3.1.3,P.I-5.1.1)*	
04.	**Noise Characteristics** ***Learning Objectives:*** 1. *To provide the statistical characteristics of different types of noise* **2.** *To perform analysis and design using simulator/editors on noise in single stage amplifiers.*	
	Contents: Statistical characteristics of noise, Types of noise - thermal noise, flicker noise, Representation of noise in single-stage amplifiers (CS, CD and CG stages), noise bandwidth.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the different statistical characteristics of Noise and its types in single stage amplifiers. (P.I.-1.3.1).* *LO 4.2: Compare and contrast between thermal noise and flicker noise in terms of their frequency behavior and circuit impact. (P.I-2.2.4)* *LO 4.3: Combine scientific principles in order to model and represent noise sources in single-stage amplifier configurations like Common Source (CS), Common Drain (CD), and Common Gate (CG) using equivalent noise circuits in terms of accuracy and applicability.(P.I-2.3.1)*	
05.	**Differential Amplifier and Operational Amplifier** ***Learning Objective/s:*** *1.To introduce the skills to design analog VLSI circuits for a given specification.*	
	Contents: Single-ended and differential operation, basic differential pair – qualitative and quantitative analysis, common-mode response, differential pair with MOS loads.	

	Performance parameters of op-amp, one stage op-amp, two-stage CMOS op-amp, Gain boosting, slew rate, power supply rejection, Simulation of differential amplifiers using SPICE. ***Self-Learning Topics:*** ***Learning Outcomes :*** *A learner will be able to* *LO 5.1: Apply the fundamental concepts of basic differential pair of operational-amplifier in single ended mode with resistive/ MOS loads to solve the common mode behavior of the circuit. (P.I.-1.3.1)* *LO 5.2: Identify relevant data from the given resources and arrive at an optimal design solution to design a differential amplifier using MOS loads and determine its gain, output swing, and input impedance for a particular application. (P.I-3.3.3)* *LO 5.3: Identify basic concepts of 2 stage amplifier and analyze all the basic performance metrics of analog VLSI design (CMRR, slew rate, voltage gain, differential gain, PSRR) for the given specifications. (P.I-2.1.3).* *LO 5.4: Develop an ability to model single/two- stage differential amplifier using open source tool and present it effectively. (P.I-1.4.1, P.I-2.3.1, P.I-3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
06.	**Bandgap Reference** ***Learning Objective/s:*** 1. *To provide a knowledge of general purpose band gap reference .* **Contents:** General considerations, Supply independent biasing, temperature-independent references, negative-TC voltage, positive TC voltage, Bandgap reference, PTAT generation, curvature correction, Design of BGR under low voltage conditions ***Self-Learning Topics:*** ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply the need for supply-independent biasing, temperature independent biasing and its importance Bandgap reference design (P.I-1.3.1)* *LO 6.2: **Identify** PTAT generation mechanism and their integration with CTAT source to create a stable reference for a given problem. (P.I-2.1.3)* *LO 6.3: **Identify relevant data d**esign a basic bandgap reference circuit and calculate its output voltage for given process parameters. (P.I- 3.3.3,)* *LO 6.4: Develop an ability to design a low-voltage bandgap reference using sub-bandgap or current-mode architectures with performance optimization. (P.I-1.4.1, P.I-2.3.1, P.I-3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.1.1, PI 9.2.1, PI 11.1.2, PI. 11.1.3)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.2.4 Compare and contrast alternative solutions to select the best methodology.
2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3 Identify sources of error in the solution process, and limitations of the solution.
3.1.6 Determine design objectives, functional requirements and arrive at specifications
3.3.3 Identify relevant data from the given resources and arrive at a best fitting design solution for particular specifications.
5.1.1 Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
8.1.1 Follow ethical practices to create a document.
8.2.1 Identify and apply moral and ethical principles of IEEE professional code of ethics.
9.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
9.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
11.1.2 Analyse different forms of financial statements to evaluate the financial status of an engineering project.
11.1.3 Identify credible estimates of the costs and benefits related to engineering project and recognize the uncertainties in the estimates due to implications of taxes and cost fluctuations on these values and comparisons.

Course Outcomes: A learner will be able to -

1. Identify, formulates, and solves engineering problems in the area of analog integrated circuits - MOS device physics, MOS models and design current mirror circuits. *(LO1.1, LO1.2, LO1.3, LO 1.4).*
2. To realise the basic concepts of switched Capacitor and analyse the circuits of switched capacitor integrator amplifier. *(LO 2.1, LO2.2, LO 2.3, LO 2.4)*
3. To apply, analyse and design single stage MOS amplifiers with noise.(*LO3.1,LO3.2, LO3.3,LO3.4,LO 3.5,LO4.1,LO4.2, LO4.3)*
4. Acquire the design principles of different categories of amplifiers like the single stage MOS amplifiers with noise, MOS differential amplifier, CMOS OPAMP .*(LO5.1,LO5.2,LO5.3,LO 5.4)*
5. Realize the concept of designing band gap reference circuits providing constant dc voltage and immune to temperature variations, noise, supply voltage fluctuations. *(LO 6.1, LO 6.2, LO 6.3, LO6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECPEC6023.1	3	3									
ECPEC6023.2	3	3									
ECPEC6023.3	3	3	2		2						
ECPEC6023.4	3	3	3		3			3	3		3
ECPEC6023.5	3	3	3		3			3	3		3
Average	3	3	3		3			3	3		3

Text Books :

1. B.Razavi , " Design of Analog CMOS Integrated Circuits" 1st Edition , Mc Graw Hill 2001.
2. Jacob Baker "CMOS Circuit Design- Layout and Simulation" (IEEE Press Series on Microelectronics Systems).
3. Gray, Meyer, Lewis and Harris, "Analysis and design of Analog Integrated Circuits", 4th Wiley International Edition
4. Sedra and Smith, Microelectronics Circuits, Oxford University Press, 2004
5. P.E Allen and D. R. Holberg, 'CMOS Circuit Design,Layout and Simulation", 2nd Edition Oxford University Press,2002.

Reference Books :

1. Harry W. Li. And David E. Boyce, "CMOS Circuit Design, Layout, Simulation, PHI Edition 2005.
2. D.A. Johns and K. Martin; Analog Integrated Circuit Design; John Wiley and Sons, 2004.
3. M. Ismail and Terri Fiez; Analog VLSI; McGraw Hill, 1994.

Other Resources :

1. NPTEL Course: Analog Circuits By Prof. Nagendra Krishnapura, IIT Madras :-Web link- Analog Circuits - Course
2. NPTEL Course: Analog Circuits By Prof. A. N Chandorkar, IIT Bombay :-Web link- Analog Circuits - Course
3. NPTEL Course: Analog Electronic Circuits By Prof. Pradip Mandal, IIT Bombay :-Web link- NOC:Analog Electronic Circuits

IN-SEMESTER ASSESSMENT (75 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Numerical Assignment/s (min 20 problems) – 05 Marks

Class test based on above numerical assignment – 05 Marks

Activity based test(Simulation): 05 Marks

Regularity and active participation:05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	ECLC609	DISCRETE TIME SIGNAL PROCESSING LABORATORY	02

Examination Scheme		
Term Work	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. ECPCC509 : Signals and Systems
2. ECPCC611 : Discrete Time signal Processing
3. ECPCC510 : Digital Communication

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO3 : Design/ Development of Solution
3. PO4: Conduct investigations of complex problems
4. PO5: Engineering tool usage
5. PO9: Individual and Collaborative team work

Course Objectives:

1. To impart the knowledge on various components of closed loop control systems.
2. To impart the knowledge on modelling and transient and steady state analysis of closed loop control systems.
3. To impart the knowledge on the analysis of control system using Root-locus and Bode-plot technique with simulation platform.

Module	Details	Hrs
	Course Introduction Introduction to Matlab: Reading , storing variables and arrays, ':' operator, loops Subplots, Plotting basic signals Array multiplications Frequency response	**01**
01.	**Signal Processing concepts** ***Learning Objective:*** *0. To teach the students to use modern programming languages to implement the signal processing concepts and techniques such as convolution, DF, correlation etc..*	**06-08**

	Experiment : a. Convolve this swept frequency response waveform with 1st order impulse responses $h1\ (n)$ = [0.5, 0.5] $and\ h2\ (n)$ = [0.5, -0.5] ; 6th order responses, test the results with two sine waves with frequencies $0.2\pi\ and\ 0.88\ pi$ b. Cross correlation: Radar Example ; Seismology example c. To determine impulse, magnitude, phase response and pole-zero plot of the transfer functions with single real pole, repeated real pole and complex poles for a=0.5, a=1 and a=2 (user input) *A learner will be able to* *LO 1.1: Apply and demonstrate the concepts of signal processing to real time signals (P 2.4.1) (PI 6.1.1)* d. DFT and effect of Zero padding e. To detect the signal frequencies buried in noise using DFT *A learner will be able to* *LO 1.2: Apply the properties of DFT to efficiently represent the given signal in the frequency domain (PI 1.1.2) (PI5.2.2)* *LO 1.3 : Perform linear filtering of long data sequences using DFT (PI 1.4.1)*	
	Self-Learning Topics: *Goertzel Algorithm, Chirp-Z Algorithm, Split Radix FFT*	
02.	**Digital filters**	**06-08**
	Learning Objective: ***1.*** *To design and analyze the digital filter for given specifications using modern tools*	
	Experiment: a. Utilize the windowing method to design the FIR filter and use them to filter the input b. Design IIR low-pass digital filter and plot its magnitude response. ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Design an appropriate digital filter (FIR/ IIR) for the given specification. (PI 2.1.2), (PI 5.2.2)* *LO 2.2: Systematically analyze the response with change in parameters. (PI 4.1.4), PI(4.3.1)* c. To study the effect of coefficient quantization on the frequency response of an IIR filter. *LO 2.3: Analyse the effect of hardware limitations on the performance of the system. (PI 2.4.2) (PI 5.1.2)*	
	Self-Learning Topics: --	
03.	**Audio and Biomedical signal processing**	**04-06**
	Learning Objectives: ***1.*** *To apply the signal processing techniques for audio and biomedical signal processing.*	
	Experiment : **Audio Signal processing:** a. To generate Echo and reverberation effects on audio signal b. Demonstration of Multirate Signal Processing for audio mixing c. Removal of high frequency noise from Speech signals using Haar filter bank	

	d. Audio Equalizers **Biomedical Signal Processing:** a. QRS separation using FIR filters and Moving Average filters b. Computation of Heart rate and Classification of ECG signals c. Envelop detection using Hilbert transform d. QRS separation using template matching e. Denoising of ECG/EMG/EEG signals	
	Self-Learning Topics: *--*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: To demonstrate advanced signal processing concepts for Music and Speech signal processing (PI 4.1.3), (PI 5.2.2), (PI 2.4.4)* *LO 3.2: To design appropriate filters for the denoising the given audio or biomedical signal (PI 2.2.3), PI(5.1.2)*	
04.	**Signal Processing applications in communication**	**02**
	Learning Objectives: ***1.*** *To guide students in implementing signal processing applications in Communication domain..*	
	Experiment : a. Split Radix FFT in OFDM b. Designing a digital SSB modulator.	
	Self-Learning Topics: Split Radix FFT	
	Learning Outcomes: *A learner will be able to* *LO 4.1: To implement advanced signal processing concepts for communication related applications (PI 4.1.3), (PI 5.2.2), (PI 2.4.4)* *LO 4.2: To design appropriate systems for the applying the signal processing concepts to signal (PI 2.2.3), PI(5.1.2)*	
05.	**Software Assignment** **Learning Objective/s***:* *To give the students an exposure to implementing signal processing techniques for real world application.* *The software assignment can be done in a group of 3-4 students.* *Learning Outcomes:* *A learner will be able to* *1. LO 5.1: Analyze the sourced technical literature to formulate an appropriate problem statement pertaining to societal relevance (PI 11.1.3)(PI 6.1.1)* *2. LO 5.2:Develop optimal engineering design solutions for the formulated problem, applying troubleshooting and critical thinking skills and present the results as a team. (PI 3.2.1) (PI 3.3.3)PI(8.3.1)PI(9.1.2) (PI 2.4.3),PI(2.1.1)*	**04-06**
	Total	**30**
Module 1 : Any 3 ; Module 2 : all 3 **Module 3 : Any 2** **Module 4 Any one Module 5 : One course project**		

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.2	Apply mathematical transforms to solve problems.
1.4.1	Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems.
2.1.1	Articulate problem statements and identify primary objectives and key constraints.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.3.2 Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4.1 Apply engineering mathematics and computations to solve mathematical models
2.4.2 Produce and validate results through skilful use of contemporary engineering techniques.
2.4.3 Identify sources of error in the solution process, and limitations of the solution.
2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6 Determine design objectives, functional requirements and arrive at specifications
3.2.1 Apply formal idea generation tools to build models/prototypes in order to develop multiple engineering design solutions.
3.3.3 Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications.
4.1.3 Apply appropriate instrumentation and/or software tools to make measurements of physical quantities.
5.2.2 Demonstrate proficiency in using discipline-specific tools.
6.1.1 Identify environmental and health issues related to engineering profession with the help of relevant viewpoints from stakeholders and propose solutions.
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts
9.1.2 Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
11.1.3 Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. Demonstrate the use of Discrete Fourier Transform (DFT) concepts and properties to analyze real-time signals using modern tools, efficiently represent them in the frequency domain, and perform linear filtering of long data sequences. *(LO 1.1, LO 1.2, LO 1.3)*
2. Design digital filters for given specifications, analyze them w.r.t. response variations, hardware limitations on system performance. *(LO 2.1, LO 2.2, LO 2.3)*
3. Implement digital filters for real world signal processing applications using appropriate software tools. *(LO 3.1, LO 3., LO 4.1, LO 4.2)*
4. Develop software prototypes for engineering solutions to real world problems, collaborate in teams, and apply critical thinking to troubleshoot challenges. (*LO 5.1, LO 5.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECLBC609.1	3	2			2	2					
ECLBC609.2		3		3	3						
ECLBC609.3		3		2	3						
ECLBC609.4		3	3					2	2		2
Average	3	3	3	3	3	2		2	2		2

Text Books :

1. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
2. Dr. K.N. Hari Bhat, Digital Communication , 2nd ED. Pearson Education .
3. Mitra SK. Digital signal processing: a computer-based approach. McGraw-Hill Higher Education; 2001 Jul 1.

4. Rangayyan RM, Krishnan S. Biomedical signal analysis. John Wiley & Sons; 2024 Feb 19.

Reference Books :

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th Edition McGraw Hill Education (India) Private Limited.
2. Dart-Enander E, Part-Enander E, Sjoberg A. The MATLAB 5 handbook. Addison-Wesley Longman Publishing Co., Inc.; 1999 Sep 1.
3. Chapman SJ. MATLAB programming for engineers. Brooks/Cole Publishing Co.; 2001 Nov 1.

A. IN-SEMESTER ASSESSMENT (25 MARKS)

Suggested breakup of distribution

Practical Exercises- 10 Marks

Internal Assessment-
Practical Test1 (Based on first 50 % of the Practical list) – 5 Marks
Software Assignment on real time signals: 5 Marks
Regularity and active participation - 5 Marks

B. END SEMESTER ASSESSMENT (Pract./Oral Exam) (25 Marks)

Students will be assessed based on three parameters:

- Conceptual knowledge
- Practical knowledge
- Oral

- Students will be randomly allocated a problem statement from the list of laboratory exercises and will be asked to draw the circuit diagram / block diagram along with the expected results and observations. The written content is checked by the examiners (Internal and External) and evaluated out of 05 Marks.

  Then the student will be allowed to start with the implementation of the experiment.

- Students will be allocated 1 hour to complete the execution. The output is then checked by both the examiners for its correctness. The weightage of the implementation is 10 Marks.

- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
SBL	ECSBL603	IMAGE PROCESSING & MACHINE VISION LABORATORY	02

Examination Scheme			
Distribution of Marks		Exam Duration (Hrs.)	Total Marks
In-semester Assessment	End Semester Examination (ESE)	ESE	
50	50	2	100

Pre-requisite:

1. ECSBL301: Python Laboratory
2. ECPCC509: Signals & Systems

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 5: Modern tool usage
6. PO 6: Ethics
7. PO 8: Individual and teamwork
8. PO 9: Communication
9. PO 11: Life-long learning

Course Objectives:

1. Develop a foundational understanding of image processing and machine vision techniques, including image acquisition, pre-processing, enhancement, and feature extraction.
2. Gain practical experience in implementing image processing algorithms using tools and programming environments like Python, or OpenCV to solve real-world problems.
3. Apply machine vision concepts to automate tasks such as object detection, pattern recognition, and quality control in various industrial and research settings.
4. Review relevant research papers, datasets, and industry case studies to gain insights into the latest advancements in 3D vision.

Module	Details	Hrs.
	Course Introduction Engineering roles that require knowledge of image processing and machine vision are in demand across various industries, including autonomous vehicles, robotics, healthcare, manufacturing, AI/ML, AR/VR, and surveillance. These engineers develop systems and algorithms to interpret, analyse, and act upon visual data in real-time,	**01**

	often integrating cutting-edge technologies like deep learning and 3D vision. Familiarity with tools such as OpenCV, MATLAB, Python is crucial for success in these roles. This course is a beginner's course which takes the learner through basics of images, their space-and frequency-domain processing, segmentation techniques, feature extraction and finally 3-D vision/depth estimation. The content is oriented in such a way that learner will develop self-learning ability through spoken tutorials, programming skills by implementing various techniques and creative skills through a case study presentation**.**	
01.	**Handling Images in Software** ***Learning Objective:*** ***To teach the basics of image formats, reading, manipulation, and performance metrics in image processing using open source software.***	**11-13**
	Demonstrations on 1. Types of images, reading-writing images, elementary manipulation of image pixels, importance of image datasets 2. Performance metrics and their significance **Suggested Tasks** 1. Use Python libraries to perform elementary pre-processing operations—such as resizing to 256×256, converting to grayscale, and normalizing pixel intensities to the 0–255 range—on a set of medical images, and save the results as a new pre-processed dataset .(LO1.1) 2. Students will be able to prepare a binary watermark logo, embed it into a dataset of images, compute performance metrics such as Mean Squared Error (MSE) between original and watermarked images, interpret the results, and document their findings. (LO 1.2)	
	Self-Learning Topics: Image resolution and Geometric transformations of images	
	Learning Outcomes: *A learner will be able to* *LO 1.1: use Python libraries to perform elementary pre-processing operations on a bunch of images sequentially, and prepare a pre-processed dataset of manipulated images. (PI 1.4.1, 5.1.1)* *LO 1.2: evaluate performance metrics, interpret their results and report in a technical document following technical writing ethics. (PI 2.4.4, 7.1.1, 9.1.2)* *Report rubric: Python programming, Accuracy of resultant datasets, Accuracy of performance metric interpretation, Quality of report, Ethics in writing.*	
02.	**Image Enhancement in Spatial and Frequency Domain** ***Learning Objective:*** 1. ***To apply spatial and frequency domain image processing techniques for enhancement, filtering, and restoration.*** 2. ***Develop hands-on skills in image segmentation, feature extraction, and transformation techniques for practical applications in image analysis.***	**15-17**

	Demonstrations on: 1. Transformations operating on image and their significance. 2. Spatial domain enhancement techniques: point processing, histogram equalization, spatial domain filters: smoothening and sharpening filters, mean, weighted averaging, median, min, max, Laplacian. 3. Images in frequency domain, Image transforms and filter design in frequency domain **Suggested Tasks** **1: Degradation and Restoration of (Medical) Images Using Spatial Domain Techniques** You are provided with a pre-processed, watermarked medical image dataset. Your task is to simulate real-world degradation scenarios and implement restoration techniques using spatial domain methods. Design and implement custom Python functions to build spatial filters with specified kernels. Apply various spatial filters such as mean, max, min, and median to restore the noisy images. Analyze the filtering results using both qualitative visualization and simple quantitative measures .(**LO 2.1)** **2: Image Enhancement in Frequency Domain and Interpretation of Results** Working with degraded images generated previously, implement image enhancement techniques using frequency domain filtering. Apply histogram equalization to enhance dull images and use advanced filtering methods like Laplacian of Gaussian (LoG) on external sample images (e.g., "rice.png") to highlight edge and detail information. Additionally, implement and analyze the effects of ideal, Butterworth, and Gaussian filters in both low-pass and high-pass configurations using OpenCV and related Python libraries. Evaluate how each filtering method affects image clarity and structure. Interpret the results by comparing visual features and quantifiable metrics .(LO 2.2)	
	Self-Learning Topics: Image Restoration	
	Learning Outcomes: *A learner will be able to* *LO 2.1: use appropriate Python libraries to perform given tasks, write the required functions with proficiency and call them using driver function. (PI 5.2.2)* *LO 2.2: Implement spatial and frequency domain enhancement methods using contemporary Python packages like OpenCV, matplotlib; interpret the obtained results and report in a technical document following technical writing ethics. (PI 2.4.2, 5.1.1, 7.1.1, 9.1.1)* *Report rubric: Python programming proficiency, Accuracy of resultant operations, Accuracy of interpretation of results obtained, Quality of report, Ethics in writing.*	
03.	**Image Segmentation and Morphology**	**13-15**
	Learning Objective: ***1. Understand and apply segmentation techniques such as thresholding, clustering, and deep learning to extract meaningful regions from images.***	

2. ***Develop practical skills in feature extraction and object detection for real-world applications like medical imaging, satellite analysis, traffic monitoring, and quality inspection***.

Demonstrations on:

1. Edge detection operations: Prewitt, Sobel, Laplacian, Canny. and segmentation methods: Threshold based segmentation, k-means clustering

2. Morphological operations: erosion, dilation, opening, closing, skeletonization, boundary detection, morphological gradient, hit-and-miss transform

Suggested Tasks:

1. Detection of White Blood Cell and Red Blood Cell is very useful for various medical applications, like counting of WBC, disease diagnosis, etc. Circle detection is the most suitable approach. Implement Canny edge detection and feature extraction techniques for blood cell identification, on the enhanced image using techniques learnt in module II.
2. In Medical Imagery, medical professionals view inside the human body in order to diagnose, monitor, and treat. There are various techniques available in the modern scientific age. A popular technique is MRI: Magnetic resonance imaging. Given an MRI image, perform **morphological segmentation** for separating the brain part, using open-source tool Octave.
3. Implement segmentation on an image from the Google Earth dataset for indicating regions of water bodies, forests, urban areas, and farmlands using **K-means clustering**.

For the above mentioned tasks:

1.Identify relevant sub-process (noise reduction, image smoothening, edge linking etc) (LO 3.1)

2. implement appropriate image enhancement and segmentation techniques (LO 3.2)

3. Prepare well documented report with the interpretation of finding for the above two tasks. (LO 3.3)

Self-Learning Topics: Watershed algorithm, Otsu's algorithm

Learning Outcomes:
A learner will be able to

LO 3.1: identify relevance of techniques learnt in practical applications and formulate sub-processes to achieve the goal specified in the tasks. (PI 6.1.1, 4.1.1)

LO 3.2: apply the image enhancement techniques learnt in previous module without any assistance to the tasks in this module and implement appropriate segmentation algorithms to achieve goal of the task. (PI 1.4.1, 5.2.2)

LO 3.3: Prepare a meaningful interpretation of the results obtained and provide in the form of a well-documented report following technical writing ethics. (PI 7.1.1, 9.1.1)

	Report rubric: Application of image enhancement techniques, Python proficiency in performing segmentation, Accuracy and interpretation of results, Quality of report, Ethics in writing.	
04.	**Object Detection, 3D Vision and Depth Estimation** ***Learning Objectives:*** ***To provide knowledge about state-of-the-art methods for depth estimation.***	**15-17**
	Demonstrations on: 1. YOLO for Object Detection 2. Depth estimation between object and camera 3. Introduction to depth estimation: Hardware based techniques like LiDAR and software-based techniques like Multi-view geometry **Suggested Tasks:** • **Case-studies (Any one)** **1.** Corner detection methods: Harris corner detection, Shi-Tomasi corner detection **2.** Texture analysis of images for feature extraction **3.** Transform features (Fourier, Wavelet, DCT) **4.** Local feature descriptors (SURF, SIFT) **5.** The original paper on YOLO (1506.02640) 6. Autonomous Vehicles: 3D Depth Perception for Object Detection (Resources: KITTI Dataset, https://ieeexplore.ieee.org/document/6957799) 7. Robotics: 3D Vision for Object Manipulation (Resources: "3D Vision-Based Object Grasping for Robotic Manipulation" – Robotics Journal, Open3D Library for 3D Vision (https://www.open3d.org/) • **Course Project**	
	Self-Learning Topics: Society/healthcare/law enforcement/governance related applications of image processing and machine vision for course project.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: read, interpret and report the given case-study based on the provided resources in the broader context of applications of the case-studies in real-life. (Individual activity) (PI 6.1.1, 9.1.2, 11.1.3)* *LO 4.2: Collaboratively apply image processing techniques learned in the course to design and implement solutions for real-life tasks, demonstrating teamwork, problem-solving skills and report writing skills. (PI 3.1.6, , 8.1.2, 9.3.3).*	
	Course Conclusion	**01**
	Total	**60**

Performance Indicators:

P.I. No.	P.I. Statement
1.4.1	Apply concepts of electronics and communication engineering and accepted practice areas to solve engineering problems.
2.1.1	Articulate problem statements and identify primary objectives and key constraints.
2.4.2	Produce and validate results through skilful use of contemporary engineering techniques.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.6	Determine design objectives, functional requirements and arrive at specifications.
3.2.2	Identify suitable criteria for evaluation of alternate design solutions.
4.1.1	Define a problem, its scope, and importance for purposes of investigation.
4.1.2	Examine the relevant methods, tools, and techniques of experiment, design, system calibration, data acquisition, analysis and presentation
5.1.1	Identify modern hardware and software engineering tools, techniques and resources for engineering activities.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.1.1	Identify social, environmental and health related issues with the help of relevant viewpoints from stakeholders and propose engineering solutions.
7.1.1	Follow ethical practices to create a document.
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective teamwork, to accomplish a goal.
9.1.1	Read, understand and interpret technical and/or non-technical information.
9.1.2	Create clear, well-constructed, and well-supported written engineering documents and/or presentation.
9.3.3	Comprehend literature, carry out background search and prepare a paper/patent draft.
11.1.3	Develop ability to learn independently through methods distinct from instructor provided materials.

Course Outcomes: A learner will be able to -

1. Apply techniques in image processing and machine vision to analyse given task, identify requirements and perform them. (LOs: 1.1, 1.2, 2.2, 3.2, 4.2)
2. Use open-source software Octave and contemporary Libraries in Python to implement the tasks proficiently with meaningful interpretation of results obtained. (LOS: 1.1, 2.1, 3.2, 4.2)
3. Prepare good quality technical report based upon each task, case study and course project following ethical principles in technical writing. (LOs: 1.2, 2.2, 3.2, 3.3, 4.2)
4. Identify resources, choose appropriate real-life problem related to image processing & machine vision, and use software tools efficiently to develop solution for the problem. (LOs 4.1, 4.2)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECSBL601.1	2	3	---	2	2	---	---	---		---	---
ECSBL601.2	---	---	---	---	2	---	---	---	3	---	---
ECSBL601.3	---	---	---	---	---	---	2	---	3	---	2
ECSBL601.4	---	---	2	---	2	2	---	---		---	2
Average	2	3	2	2	2	2	2	---	3	---	2

NOTE: CO can be mapped to PO at level 3 if at least two PIs are associated with that CO; otherwise, it can be mapped at level 2.

Text Books:

1. **Digital Image Processing** by Rafael C. Gonzalez and Richard E. Woods.
2. **Learning OpenCV 4: Computer Vision with Python** by Gary Bradski and Adrian Kaehler.

Reference Books:

1. **Computer Vision: Algorithms and Applications** by Richard Szeliski.
2. **Programming Computer Vision with Python** by Jan Erik Solem.

Other Resources:

1. OpenCV documentation: OpenCV: OpenCV modules
2. Kaggle Datasets: Find Open Datasets and Machine Learning Projects | Kaggle

A. IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

a. Practical Exercises and case study report - 10 Marks

Students will be given number of experiments as mentioned in the syllabus. Each experiment carries 10 Marks. Average will be taken of all experiments. Students are expected to listen to the spoken tutorials and perform the assigned tasks in the experiments as per requirement. They are expected to prepare a brief report of each experiment, which includes the task description, program, results obtained, discussion on results and conclusion.

b. Mid-term Test: 15 Marks

Students will be allotted a Test-paper based upon first two modules individually. Tasks will be evaluated for proficiency in coding, accuracy of results and concluding answers provided for the questions asked in the task-sheet.

c. Course project presentation– 20 Marks

Students will be allotted Course project in a group of two-to-three students from a batch. The case study will be based on module 6 whereas course project will be based on techniques learnt in the entire course. The presentation will be carried out for 35 marks. The guideline for assessment is as follows.

i. Clarity in presenting the objectives: 10 marks (Group assessment)

ii. Lucidity in explanation of methodology and results: 20 marks (Individual assessment)

iii. Q/A: 5 marks (Individual assessment)

d. **Regularity and active participation - 5 Marks**

B. END SEMESTER EXAMINATION (50 Marks)

Unified task execution: 30 marks

Learner will be given problem statements which interlink learning outcomes of multiple modules from module 1 to 5. Learner will be expected to perform the tasks given in the problem statement individually and demonstrate results. The assessment will be on following parameters;

i. breaking down the complex problem in smaller parts: 6 marks

ii. executing the small tasks correctly: 10 marks

iii interlinking the results of smaller tasks to perform the unified task correctly: 10 marks

iv presenting the results in a clearly written report: 4 marks

Example: A dataset containing 10 images is provided to you. Resize all the images to 64x64, perform smoothening on all the images and generate feature vector of SIFT features from the smoothened images. Display all the three stages as images.

Viva-voce on the course-modules: 20 marks

Two examiners, one Internal and one External will do the ESE evaluation.

Course Type	Course Code	Course Name	Credits
MNP	ECMNP604	MINI PROJECT- 2B	01

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Engineering Tool Usage
6. PO6 : The Engineer & World
7. PO7 : Ethics
8. PO8 : Individual & Collaborative team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester VI (50 marks):
  - 20 marks for the In-Semester Two Presentations
  - 05 marks for Participation in Project Competitions, TPP, etc.
  - 20 marks for the Final Report & Presentation
  - 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.

- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
ELC	ELC601	Research Methodology	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer & The World.
4. PO7: Ethics
5. PO8: Individual & Collaborative team work
6. PO9: Communication
7. PO11: Life-long learning

Course Objectives:

1. To gain the knowledge of use research tools and techniques to design research projects and form the hypothesis.
2. To familiarize students about the literature review practice for identifying the research gap.
3. To gain the knowledge about collection of data and qualitative/ quantitative analysis of data and results
4. To understand the key practices in preparation of a research report / paper.
5. To foster ethical practices in research and publications

Module	Details	Hrs
00	**Course Introduction:** This course aims to introduce students to the important aspects of research. The course is intended to make students aware of formal research and to overcome common misconceptions in research that may be present in their minds. At the end of this course, students shall be able to take up research activities in a more systematic and formal manner right from the beginning. This course on Research Methodology learned through experiential learning mechanism can play a significant and holistic role in contributing to the personal and professional development of students.	1
1	**Fundamentals of Research Methodology**	4-5
	Content: Types of Research, Research approaches, Empirical research methods, Significance of research, Research design, Case study method, Sampling technique, Sources of data, Selection of research problem, Research Ethics and Empiricism *Exercise: A group discussion on what is research and ethics in research with related case studies shall be conducted.*	
2	**Formulation of a Research Problem & Hypothesis formulation**	4-5

	Content: Selection and formulation of a research problem, Objectives of formulation, Criteria of a good research problem, Literature Review Process and Formulation of Research Questions Hypothesis-Characteristics and Hypothesis Testing –Logic and Importance *Exercise: Groups of students shall make Technical Presentations on Selection of a research problem and Hypothesis formulations based on topics given.*	
3	**Research Design**	**4-5**
	Content: The Research framework, Research design: Need, Characteristics & Components; Experimental and non-experimental designs, Experimental and non-experimental hypothesis testing. Classification schemes for research design, Principles of experimental designs, Writing rationale for a research *Exercise: Students shall prepare the framework of research methods and techniques to conduct a study on a given real life case study covering key elements of the module.*	
4	**Sampling Method**	**3-4**
	Content: Probability or random sampling, Cluster sampling, Area sampling, Multi-stage sub-sampling, Random sampling with probability proportional to size, Non-probability sampling. *Exercise: A real life case study shall be demonstrated to students covering key elements of the module shall be covered.*	
5	**Data Collection & Data Analysis**	**4-5**
	Content: Sources of data, Collection of data, Measurement and scaling technique, Collection of data from appropriate sources (primary and secondary), Correlation and causation, Classification of quantitative analysis. Selection and analysis of multi-variate methods, Performing data analysis and presentation of results, Case study method. *Exercise: Group of students shall carry out exercise of real life data collection on a given research problem and data analysis and submit the report*	
6	**Report Writing and Journal Publication**	**3-4**
	Content: Preparation of a research report, Formats and Contents of report: Literature review, Presentation of research work, Research Design & Analysis, Results, Findings, and Contribution, Significance of research, and Conclusion. Mechanics of writing papers in Peer-reviewed Journals / Reputed Conferences. Ethics in Publication. *Exercise: Students shall prepare & submit a paper (4-5 pages) in a standard format (suitable universally accepted journal publication format) based on the exercises / research case study carried out in this course.*	
7	***Course Conclusion***	**1**
	Total	**30**

Course Outcome: Learner will be able to

CO1: Identify and demonstrate the importance of research process in science and technology domains
CO2: Perform literature reviews using print and online databases.
CO3: Analyse the data using qualitative and quantitative methods
CO4: Identify and prepare the key elements of a research report/ paper
CO5: Illustrate the rationale for research and publication ethics

Text Books:

1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publisher, 2014.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage Publication, 2018
3. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2014

Reference Books:

1. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Ed., SAGE, 2018.Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2005.
2. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
3. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

Other Resources:

NPTEL Course: Research Methodology By Prof. Edamana Prasad, Prof. Prathap Haridoss (IIT Madras)
Weblink https://onlinecourses.nptel.ac.in/noc25_ge28/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6011	ART OF LIVING	02

Program Outcomes addressed:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO8 : Individual and Collaborative Team Work
4. PO9: Communication
5. PO11: Life-long learning

Course Objectives :

1. To provide a comprehensive understanding of the principles of the Art of Living and their relevance to holistic well-being.
2. To equip participants with practical techniques like Sudarshan Kriya, yoga, and mindfulness for stress management and emotional balance
3. To enable participants to apply the Art of Living principles to enhance relationships, productivity, and life purpose.

Module	Details
01.	**Introduction to the Art of Living** Understanding the Mind and Stress, Breath and Life Energy, Basics of Yoga and Guided Meditation
02.	**Sudarshan Kriya and Breathing Techniques** Introduction to Sudarshan Kriya, Practicing Rhythmic Breathing Techniques
03.	**Emotional Well-being** Understanding and Balancing Emotions, Forgiveness and Gratitude Practices, Guided Meditation for Emotional Healing
04.	**Relationships and Social Connections** Compassion and Effective Communication, Stress-free Relationships, Group Activities for Trust and Collaboration
05.	**Living with Purpose and Awareness** Discovering Life Purpose, Mindfulness Practices, Time Management and Productivity
06.	**Sustaining the Practices** Developing a Daily Routine, Advanced Breathing Techniques, Reflections, and Closing Meditation
Total no. of hours: **30**	

Course Outcomes :

1. Gain insights into managing stress and emotions through breathwork and meditation
2. Develop skills for building harmonious relationships and enhancing emotional intelligence.
3. Cultivate mindfulness, compassion, and clarity in daily life.
4. Sustain the Art of Living practices for long-term well-being and self-discovery.

Text Books :

1. "Celebrating Silence" by Sri Sri Ravi Shankar (1999, Sri Sri Publications Trust)
2. "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar (1995, Inner Traditions International)
3. "The Miracle of Mindfulness" by Thich Nhat Hanh (1975, Beacon Press)

Reference Books :

1. "Wisdom for the New Millennium" by Sri Sri Ravi Shankar (2000, Sri Sri Publications Trust)
2. "The Healing Power of the Breath" by Richard P. Brown and Patricia L. Gerbarg (2012, Shambhala Publications)

Course Type	Course Code	Course Name	Credits
LLC	LLC6012	Yoga and Meditation	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To raise awareness of the therapeutic and preventive benefits of Yoga and Meditation
2. To nurture Holistic wellness through the harmony of body, mind and self
3. To advocate for the application of Yogic science in the treatment and prevention of psychosomatic and Lifestyle disorders.
4. To inspire the practice of Yogic Science tools for fostering health and well-being in daily life.
5. To promote the art of purposeful and mindful living by cultivating a deep sense of oneness with the self, nature and the world.

MODULE	DETAILS
1.	**Introduction to Yoga and Meditation** Definition of Yoga, Importance of Yoga for Human life, Literature of Yoga: Yoga Sutra, Bhagavat Gita – Synthesis of Yoga, Hathapradipika etc. Challenges of health in students & youth - Studies, Yogic concept of Health and Meditation, Concept of Body and Disease in Yoga, Dimensions of Health- Physical, Mental, Social and Spiritual, Different types of yoga (Karma, Gyaan, Ashtanga, Bhakti), Eight limbs of ashtanga yoga.
2.	**Yoga and Wellness** Yoga and Medical perspectives – Health related fitness, Yoga for common ailments, Scientific Researches in Yoga, Yogic anatomy of Human body, Asanas – Definitions and classifications, Scientific reasoning behind the asanas, Yoga for Stress, Technostress and Lifestyle management. Mental Disturbances and Preventive, Curative Aspect of Yoga for Mental wellness.

3.	**Essentials of Yoga Practices** Difference between Yoga and Exercise, Obstacles in the path of Yogic Practices, Disciplines in Yogic practices – Prayers, Yama, Niyama, Place, Time, Diet, Schedule, Sequence for Yogic Practices. Yogasanas: Surya Namaskara, Standing asanas and Sitting asanas, Different groups of Yogasanas – Relaxation, Meditative, Digestive etc. Psycho-physiological effects and health benefits of Yogasana, Function and effect of Asanas - Digestive system, Respiratory system, Excretory system, Circulatory system, Nervous system etc.
4.	**Meditation – Role of Breath and Pranayama** Yogic anatomy, Wellness and Triguna system, Science of Pranayama – 'Prana', the vital principle, Prana and air element, Awareness - Breath Awareness, Different types of Breathing, Breath Control, Breath and Postures, Rhythmic Breathing, Pranic body in the five-fold body (Panchakosha), Power of breath, Difference between Pranayama and breathing, Prana and nervous system, Fivefold function of prana, Benefits of pranayama
5.	**Fundamental aspects of Meditation** Pranayama and deep breathing - Concept of Inhalation (Puraka), Retention (Kumbhaka), & Exhalation (Rechaka); Important Pranayamas; Pranayama and Meditation; Mind and Meditation; Inner Instrument – Mind, Constituents of Mind - Mana, Buddhi, Ahankar and Chitta(Consciousness), Magnitude of Mind, Buddhi – the determinative faculty; Body-Mind complex; Mind Cleansing; Yogic Meditation and Mindfulness meditations; Yogic Process and Outcome of Meditation – Pratyahara, Dharana and Dhyana; Scientific studies on Meditation and Healing.
6.	**Meditation Tools and Techniques** Why Meditate - States of Mind, Mind over Body – Processing Thoughts, Preparing for Meditation – Posture, Shanti prayers, Pranayama, Training the Mind: Practicing tools- Bhramari Pranayama, Sacred Pranav (Om) mantra, Mantra Japa/ajapa, Types of Mindfulness Meditations, Yoga Nidra, Body scan meditation, etc. Benefits of Meditation

Course Outcomes:

1. Gain comprehensive insights about the necessity of yoga for daily life.
2. Obtain a simplified understanding of the impact of mindful breathing on health wellbeing.
3. Acquire knowledge of 'practice and principles' of simple awareness meditation for Mental wellness
4. Gain required knowledge to improve overall health and immune system
5. Practice simple asanas and meditation techniques to improve concentration, self- confidence and inner peace

Text Books:

1. Light on the Yoga Sutras of Patanjali by B.K. Iyengar (Publisher: Orient Longman Pvt. Ltd. Mumbai)
2. Pranayama - The Art & Science by Dr. Nagendra H R (Publisher: Swami Vivekananda Yoga Prakashan, Bangalore)
3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Recommended Books

1. Pranayama-Science of Breath by Gharote, M. (Publisher: The Lonavla Yoga Institute, India)
2. Svatmarama's HathaYogaPradeepika by Gyan Shankar Sahay (Publisher: Yogic Heritage, India)
3. Yoga for Health and Peace by Padamshree Sadashiv Nimbalkar (Publisher: Yoga Vidya Niketan, Mumbai)

Other Resources:

1. NPTEL Course: Yoga and Positive Psychology for Managing career and life by Prof. Ashish Pandey, IIT Bombay.
Weblink https://archive.nptel.ac.in/courses/110/101/110101165/

2. SWAYAM Course: Yoga for Concentration by By Dr H R Nagendra, Dr Manjunath N K and Dr Apar Avinash Saoji from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore.
Weblink: https://onlinecourses.swayam2.ac.in/aic23_ge05/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6013	Health and Wellness	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper.
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques.

MODULE	DETAILS
1.	**Foundations of Health Well-being** Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche Yogic anatomy of Physiological and Psyche layers, Triguna system
2.	**Physical Wellbeing** Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation
3.	**Emotional Wellness** Types of Emotions, Symptoms of emotional wellness Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc. Emotions and physical wellness Understanding the trinity of senses, sense objects and emotions, Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness

4.	**Mental Wellness** What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety, behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements
5.	**Intellectual Wellness** Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness
6.	**Spiritual Wellness** Yogic understanding of term 'spiritual' Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness Studies on Spiritual wellness and Body Healing Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements

Course Outcome:
Learner will be able to

1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

Text Books

1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher: Nisargopachar Gramsudhar Trust, Pune)

2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)

3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

Reference books

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)

2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
(Publisher: Motilal Banarsidass Publishing House, Delhi)

3. Yog – Its Philosophy and Practice by Swami Ramdev
(Publisher: Divya Prakashan, Haridwar)

Other Resources:

1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur.
Weblink https://nptel.ac.in/courses/127105236

2. NPTEL Course: The Science of Happiness and Wellbeing by By Prof. Priyadarshi Patnaik, Prof. Manas K. Mandal from IIT Kharagpur.
Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6013	Health and Wellness	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper.
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques.

MODULE	DETAILS
1.	**Foundations of Health Well-being** Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche Yogic anatomy of Physiological and Psyche layers, Triguna system
2.	**Physical Wellbeing** Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation
3.	**Emotional Wellness** Types of Emotions, Symptoms of emotional wellness Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc. Emotions and physical wellness Understanding the trinity of senses, sense objects and emotions, Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness

4.	**Mental Wellness** What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety, behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements
5.	**Intellectual Wellness** Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness
6.	**Spiritual Wellness** Yogic understanding of term 'spiritual' Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness Studies on Spiritual wellness and Body Healing Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements

Course Outcome:
Learner will be able to

1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

Text Books

1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher: Nisargopachar Gramsudhar Trust, Pune)

2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)

3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

Reference books

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)

2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
(Publisher: Motilal Banarsidass Publishing House, Delhi)

3. Yog – Its Philosophy and Practice by Swami Ramdev
(Publisher: Divya Prakashan, Haridwar)

Other Resources:

1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur.
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Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6014	DIET AND NUTRITION	02

Program Outcomes addressed:

1. PO6 : The Engineer & Society
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To provide students with a comprehensive understanding of nutrition principles and their application in promoting optimal health.
2. To develop critical thinking skills to evaluate nutritional information and make informed decisions.
3. To apply knowledge of nutrition education and counselling to promote healthy nutrition practices in individuals and group.
4. To demonstrate an understanding of role of nutrition in disease prevention and management.

Module	Details
01.	**Nutrition for wellness -1** Introduction to nutrition, food pyramid, Macros: Carbohydrates, Protein and fats, Micros: Vitamins A C E K and D, Minerals-Calcium, Iron and Zinc Importance of hydration, signs and symptoms, stages of dehydration.
02.	**Nutrition wellness -2** Introduction to mindful eating, plate concept, understanding physical and emotional hunger, eating disorder-Anorexia nervosa, bulimia nervosa and binge eating.
03.	**Exercise and fitness** Introduction to exercise and its importance, types of exercise its classification, side effects of over exercising, Impact of sedentary lifestyle on body composition.
04.	**Sleep and relaxation** Flow of circadian rhythm, sleep cycle, stages of sleep, sides effects, sleeping disorder- sleep apnea, insomnia, sleep hygiene routine and foods inducing sleep
05.	**Managing stress** Introduction to stress, causes, effects of stress, management of stress, foods and adaptogenic foods for stress management.
06.	**The lifestyle flow** Morning/ wake up rituals, meal flow i.e in which order to eat, post meal flow, bedtime rituals – how should your last hour of the day look like
Total no. of hours: **30**	

Course Outcomes :

1. Understand the fundamentals of nutrition and its role in promoting wellness.
2. Apply mindful eating practices to manage physical and emotional hunger.
3. Assess the importance of exercise and its impact on health and fitness
4. Gain insights into sleep hygiene and manage sleep-related disorders.
5. Develop strategies for stress management using nutrition and adaptogenic foods.
6. Assess the importance of exercise and its impact on health and fitness

Text Books :

1. Nutrition and dietetics by C.S. shah: covers various aspects of nutrition, including nutrient metabolism, dietary planning and diet therapy.
2. Dietetics by B. Srilakshmi- covers aspects of dietetics including nutrition, food science and diet therapy.

Reference Books :

1. Nutrition science by B. Shrilakshmi: provides an overview of nutrition, nutrient metabolism and dietary patterns
2. Food science by B. Shrilakshmi covers food, including food composition, food processing and food safety.

Course Type	Course Code	Course Name	Credits
LLC	LLC6015	PERSONALITY DEVELOPMENT	02

Program Outcomes addressed:

1. PO6 : The Engineer & Society
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To enhance self-awareness and self-confidence in the students.
2. To develop effective communication, leadership, and interpersonal skills.
3. To equip students with stress management and time management techniques.
4. To foster teamwork, problem-solving, and decision-making abilities.
5. To prepare students for professional life through resume building, interview skills, and networking.
6. To instill a growth mindset and adaptability in personal and professional contexts.

Module	Details
01.	**Self-Awareness and Emotional Intelligence** Understanding personality traits and self-assessment, Importance of emotional intelligence (EI) in personal and professional success, Strategies to enhance EI and self-awareness.
02.	**Communication Skills** Fundamentals of verbal and non-verbal communication, Public speaking, presentation skills, and storytelling, Listening skills and constructive feedback.
03.	**Leadership and Teamwork** Understanding importance of self-confidence, leadership styles, and their applications, Building effective teams and managing conflicts, Developing collaboration and networking skills.
04.	**Stress and Time Management** Recognizing stressors and managing stress effectively, Prioritization and goal-setting techniques, Tools for efficient time management and productivity.
05.	**Professional Development** Importance of presentation skills, resume writing, cover letter, and LinkedIn optimization, Interview preparation: Mock interviews and common questions, Networking skills and professional etiquette
06.	**Personal Growth and Adaptability** Developing a growth mindset and embracing lifelong learning, Cultivating resilience and adaptability to change, Setting long-term personal and professional goals
Total no. of hours: **30**	

Course Outcomes : By the end of this course, students will be able to:

1. Demonstrate increased self-awareness and emotional intelligence.
2. Communicate effectively in professional and personal contexts.
3. Exhibit leadership and teamwork skills in various scenarios.
4. Manage time and stress efficiently to enhance productivity.
5. Prepare a professional resume, excel in interviews, and network effectively.
6. Develop resilience, adaptability, and a growth-oriented mind-set.

Text Books :

1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ / What Makes a Leader: Why Emotional Intelligence Matters
2. Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change

Reference Books :

1. Dale Carnegie, How to Win Friends and Influence People.
2. Anthony Robbins, Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical, and Financial Destiny!
3. David J. Schwartz, The Magic of Thinking Big.
4. Robin Sharma, The Monk who sold his Ferrari.
5. Dorie Clark, Reinventing You: Define Your Brand, Imagine Your Future.
6. Gangadhar Joshi, Campus to Corporate: Your Roadmap to Employability.

Other Resources :

1. Videos and TED Talks by Simon Sinek, Brené Brown, Malcolm Gladwell and other motivational speakers
2. Online courses on communication and leadership (e.g., Coursera, LinkedIn Learning, EdX).