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 and

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

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

with Effect from AY 2024-2025
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.

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

*For Tutorials

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.*	**06-08**
	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)*	
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.*	**07-09**
	Contents: Introduction, Concept of complex frequency, Immittance functions, Poles and zeros of network functions, Necessary condition for driving point Immittance functions and transfer function	

	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. Continuous Assessment - Tutorial (25 Marks)

Suggested breakup of distribution

a) Tutorial Assignments and Class tests: 20 Marks

Students need to solve (in the class only during tutorial hour) 08 tutorials provided by the course coordinator on entire syllabus. Each tutorial carries 20 Marks. Average will be taken of all tutorial marks.

b) 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**	**07-09**
	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)*	
	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

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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