AC-01-Item No. 2.0, 2.4, 3.0 & 3.4 dated 29th April 2024

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 Electrical Engineering

Curriculum Structure FY to B.Tech

&

Third Year Syllabus

Prepared by: Board of Studies for Electrical Engineering

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

Effective from: 2025-26

Revision: 2024.1

PREAMBLE-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 toindividual 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- BOS CHAIRPERSON

Established in 1994, the Electrical Engineering department, provides comprehensive programs spanning undergraduate, postgraduate, and Ph. D levels. Comprising a team of highly qualified and experienced faculty, the department distinguishes itself through its cutting-edge facilities such as the Renewable Laboratory, Protection Laboratory, Power Electronics, Drives and Control System Laboratory. Additionally, the program has received accreditation thrice in 2005, 2012, and 2018, maintaining its validity to date. Furthermore, the institute is scheduled to transition to autonomy from the academic year 2024-25.

The scheme and syllabus of the Department of Electrical Engineering under autonomy are centred entirely on fostering the development of learners and cultivating the essential attributes that graduates should possess. When crafting the curriculum, two primary considerations are taken into account: the essential domain knowledge, skill sets, and tools required for the diverse career paths available to contemporary Electrical engineers and the 12 attributes of Program Outcomes mandated by regulatory bodies. The NBA-SAR January 2016 serves as a benchmark for shaping the learning outcomes within each module of the syllabus. Electrical engineering curriculum is structured to cover a range of core areas and specialized topics, ensuring that graduates are well-equipped to tackle the challenges of the modern world.

National Educational Policy-2020 guidelines are considered as reference while designing the curriculum. It incorporates practical learning opportunities like mini projects and major projects, skills-based labs, and internships to foster creativity and problem-solving abilities. Furthermore, offering value-added courses, honours programs, and minors ensures a well-rounded educational experience that caters to students' unique interests and goals.

The curriculum offers abundant chances for educators to pioneer teaching methods and assessment approaches, with the goal of enriching students' learning experiences and cultivating a lifelong passion for learning.

With a strong foundation in electrical engineering principles and specialized knowledge in key areas, graduates of our program are well-prepared to make significant contributions to the field and drive innovation in technology.

As we embark on this transformative journey, we invite all stakeholders to join us in shaping the future of Electrical Engineering education.

BOS Chairperson,
Department of Electrical Engineering.

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A. Abbreviations

AEC	Ability Enhancement Course
AU	Audit Course
BSC	Basic Science Course including Mathematics
BSL	Basic Science Laboratory Course
ELC	Experiential Learning Course
ESC	Engineering Sciences Course
ESL	Engineering Sciences Laboratory Course
HMC	Honours or Minor Core Course
HML	Honours or Minor Laboratory
HMP	Honours or Minor Mini Project
HSS	Humanities Social Sciences and Management Course
IKS	Indian Knowledge System Course
INT	Internship
L	Lecture
LBC	Laboratory Course
LLC	Liberal Learning Course
MDM	Multidisciplinary Minor Course
MDL	Multidisciplinary Laboratory Course
MJP	Major Project
MNP	Mini Project
OEC	Open Elective Course
P	Practical
PCC	Program Core Course
PEC	Program Elective Course
RPC	Research Project Coursework
RPR	Research Project
SBL	Skill Based Laboratory
SEC	Skill Enhancement Course
T	Tutorial
VEC	Value Education Course

B. Credit Structure

1. B. Tech in Electrical 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**

† NOTE: The Multidisciplinary Laboratory Course can be moved to the sixth semester if the department prefers

C Curriculum Structure and Examination Scheme for B. Tech in Electrical Engineering

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

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

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

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

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

Examination Scheme – FY Semester-I

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

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

@For continuous assessment of tutorials.

Curriculum Structure – FY Semester-II

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

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

Examination Scheme – FY Semester-II

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

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

@For continuous assessment of tutorials.

Curriculum Structure – SY Semester-III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEPCC301	Engineering Mathematics-III	3	--	1	3	--	1	4
EEPCC302	Circuit and Signal Analysis	3	--	1	3	--	1	4
EEPCC303	Elements of Power System	3	--	--	3	--	--	3
EEPCC304	Renewable Sources and Energy Storage	3	--	--	3	--	--	3
XXMDM301Y#	--	3	--	--	3	--	--	3
EELBC301	Electronics Laboratory	--	2	--	--	1	--	1
EELBC302	Electrical System Laboratory	--	2	--	--	1	--	1
EESBL301	Python Laboratory	--	4	--	--	2	--	2
EEMNP301	Mini Project-1A	--	3	--	--	1	--	1
HSS301	Product Design	2	--	--	2	--	--	2
	Total	**17**	**11**	**2**	**17**	**5**	**2**	**24**

#Four theory courses (Three 3-credit courses and one 4-credit course) and one laboratory course (1 credit) offered by other department has to be taken by electrical students, to complete the 14 credit requirements 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	
EEPCC301	Engineering Mathematics-III	20+25@	30	50	1.5	2	125
EEPCC302	Circuit and Signal Analysis	20+25@	30	50	1.5	2	125
EEPCC303	Elements of Power System	20	30	50	1.5	2	100
EEPCC304	Renewable Sources and Energy Storage	20	30	50	1.5	2	100
XXMDM301Y	--	20	30	50	1.5	2	100
EELBC301	Electronics Laboratory	25	--	25	--	--	50
EELBC302	Electrical System Laboratory	25	--	25	--	--	50
EESBL301	Python Laboratory	50	--	50	--	--	100
EEMNP301	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
EEPCC405	Engineering Mathematics-IV	3	--	1	3	--	1	4
EEPCC406	Control System	3		--	3	--	--	3
EEPCC407	Power Electronics	3	--	--	3	--	--	3
EEPCC408	Power System Engineering	3	--	--	3	--	--	3
XXMDM402Y	--	3	--	--	3	--	--	3
EELBC403	Power Electronics Laboratory	--	2	--	--	1	--	1
EELBC404	Control System Laboratory	--	2	--	--	1	--	1
EELBC405	Measurement and Instruments Laboratory	--	2	--	--	1	--	1
EESBL402	PCB Fabrication and Circuit Testing Laboratory	--	4	--	--	2	--	2
EEMNP402	Mini Project – 1B	--	3	--	--	1	--	1
VEC402	Environment and Sustainability	2	--	--	2	--	--	2
	Total	**17**	**13**	**1**	**17**	**6**	**1**	**24**

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	
EEPCC405	Engineering Mathematics-IV	20+25@	30	50	1.5	2	125
EEPCC406	Control System	20	30	50	1.5	2	100
EEPCC407	Power Electronics	20	30	50	1.5	2	100
EEPCC408	Power System Engineering	20	30	50	1.5	2	100
XXMDM402Y	--	20	30	50	1.5	2	100
EELBC403	Power Electronics Laboratory	25	--	25	--	--	50
EELBC404	Control System Laboratory	25	--	25	--	--	50
EELBC405	Measurement and Instruments Laboratory	25	--	25	--	--	50
EESBL402	PCB Fabrication and Circuit Testing Laboratory	50	--	50	--	--	100
EEMNP402	Mini Project – 1B	50	--	50	--	--	100
VEC402	Environment and Sustainability	50	--	--	--	--	50
	Total	**350**	**150**	**425**	--	--	**925**

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

@For continuous assessment of tutorials.

Curriculum Structure – TY Semester-V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEPCC509	Electrical Machines	3	--	--	3	--	--	3
EEPCC510	Protection and Switchgear	3	--	--	3	--	--	3
XXMDM503Y	--	3	--	--	3	--	--	3
EEPEC501Y	Program Elective Course-I	3	--	--	3	--	--	3
EELBC506	Switchgear and Safety Laboratory	--	2	--	--	1	--	1
EELBC507	Electrical Machines Laboratory	--	2	--	--	1	--	1
XXMDL501Y	--	--	2	--	--	1	--	1
AEC502	Professional Communication and Ethics-II	1	2	--	1	1	--	2
EEMNP503	Mini Project-2A	--	3	--	--	1	--	1
HSS502	Entrepreneurship	2	--	--	2	--	--	2
Total		**15**	**11**	**--**	**15**	**5**	**--**	**20**

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

Program Elective Course-I:

Students should take one PE from the following list of Program Elective Course- I.

Course Code	Program Elective Course-I
EEPEC5011	Advanced Power Electronics
EEPEC5012	Engineering Electromagnetics
EEPEC5013	Electric Vehicle Technology

Examination Scheme – TY Semester-V

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
EEPCC509	Electrical Machines	20	30	50	1.5	2	100
EEPCC510	Protection and Switchgear	20	30	50	1.5	2	100
XXMDM503Y	--	20	30	50	1.5	2	100
EEPEC501Y	Program Elective Course-I	20	30	50	1.5	2	100
EELBC506	Switchgear and Safety Laboratory	25	--	25	--	--	50
EELBC507	Electrical Machines Laboratory	25	--	25	--	--	50
XXMDL501Y	--	25	--	25	--	--	50
AEC502	Professional Communication and Ethics-II	50	--	--	--	--	50
EEMNP503	Mini Project-2A	50	--	--	--	--	50
HSS502	Entrepreneurship	50	--	--	--	--	50
	Total	**305**	**120**	**275**	--	--	**700**

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

Curriculum Structure – TY Semester-VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEPCC611	Drives and Control	3		--	3	--	--	3
XXMDM604Y	--	4		--	4	--	--	4
EEPEC602Y	Program Elective Course-II	3	--	--	3	--	--	3
EELBC608	Drives and Control Laboratory	--	2	--	--	1	--	1
EELBC609	Electrical Software Laboratory	--	2	--	--	1	--	1
EESBL603	Industrial Automation Laboratory	--	4	--	--	2	--	2
EEMNP604	Mini Project-2B	--	3	--	--	1	--	1
ELC601	Research Methodology	2	--	--	2	--	--	2
LLC601Y*	Liberal Learning Course	2	--	--	2	--	--	2
	Total	**14**	**11**	**--**	**14**	**5**	**--**	**19**

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

***Liberal Learning Course:**

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

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

Program Elective Course-II:

Students should take one PE from the following list of Program Elective Course- II.

Course Code	Program Elective Course-II
EEPEC6021	Lighting System Design
EEPEC6022	High Voltage DC transmission
EEPEC6023	Advanced Control System

Examination Scheme – TY Semester-VI

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
EEPCC611	Drives and Control	20	30	50	1.5	2	100
XXMDM604Y	--	20	30	50	1.5	2	100
EEPEC602Y	Program Elective Course-II	20	30	50	1.5	2	100
EELBC608	Drives and Control Laboratory	25	--	25	--	--	50
EELBC609	Electrical Software Laboratory	25	--	25	--	--	50
EESBL603	Industrial Automation Laboratory	50	--	50	--	--	100
EEMNP604	Mini Project-2B	50	--	50	--	--	100
ELC601	Research Methodology	50	--	--	--	--	50
LLC601Y*	Liberal Learning Course	50	--	--	--	--	50
	Total	**310**	**90**	**300**	--	--	**700**

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

Curriculum Structure – B. Tech Semester-VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEPCC712	Electrical Systems Design and Auditing	3	--	--	3	--	--	3
EEPEC703Y	Program Elective Course-III	3	--	--	3	--	--	3
EEPEC704Y	Program Elective Course-IV	3	--	--	3	--	--	3
OEC701Y	Open elective Course –I	3	--	--	3	--	--	3
EELBC710	Electrical System Design and Audit Laboratory	--	2	--	--	1	--	1
EELBC711	Applied Power Electronics Laboratory	--	2	--	--	1	--	1
EEMJP701	Major Project A	--	6	--	--	2	--	2
HSS703	Financial Planning	2	--	--	2	--	--	2
	Total	**14**	**10**	**--**	**14**	**4**	**--**	**18**

Program Elective Course-III:

Students should take one PE from the following list of Program Elective Course- III.

Course Code	Program Elective Course-III
EEPEC7031	Power System Operation and Control
EEPEC7032	Digital VLSI Design
EEPEC7033	Automation and Control

Program Elective Course-IV:

Students should take one PE from the following list of Program Elective Course- IV.

Course Code	Program Elective Course-III
EEPEC7041	Smart Power System
EEPEC7042	Power Quality and FACTS
EEPEC7043	Artificial Intelligence in Renewable Energy System

Open Elective Course - I

Every student is required to take one Open Elective Course-I for Semester VII. Students can take this course from the following list of Open Elective Course-I.

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

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

Examination Scheme – B. Tech Semester-VII

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	
EEPCC712	Electrical Systems Design and Auditing	20	30	50	1.5	2	100
EEPEC703Y	Program Elective Course-III	20	30	50	1.5	2	100
EEPEC704Y	Program Elective Course-IV	20	30	50	1.5	2	100
OEC701Y	Open elective Course –I	20	30	50	1.5	2	100
EELBC710	Electrical System Design and Audit Laboratory	25	--	25	--	--	50
EELBC711	Applied Power Electronics Laboratory	25	--	25	--	--	50
EEMJP701	Major Project A	50	--	--	--	--	50
HSS703	Financial Planning	50	--	--	--	--	50
Total		**230**	**120**	**250**	--	--	**600**

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

Curriculum Structure – B. Tech Semester-VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEPEC805Y		3	--	--	3	--	--	3
OEC802Y		3	--	--	3	--	--	3
EEMJP802	Major Project-B	--	12	--	--	4	--	4
INT801	Internship~	--	--	--	--	8	--	8
	Total	**6**	**12**	**--**	**6**	**12**	**--**	**18**
~ Students have the opportunity to engage in a three-month internship within industry, research organizations, foreign universities, or internal internship for research and product development during the 8th semester, provided they meet the semester requirements and receive approval from the institute.								

Program Elective Course-V:

Students should take one PE from the following list of Program Elective Course- V.

Course Code	Program Elective Course-V
EEPEC8051	Power Electronics and Control
EEPEC8052	Advanced Power System
EEPEC8053	Microgrid and Smart Grid

Open Elective Course -II

Every student is required to take one Open Elective Course-II for Semester VIII. Students can take this course from the following list of Open Elective Course-II.

Course Code	Open Elective Course-II
OEC8021	Project Management
OEC8022	Finance Management
OEC8023	Entrepreneurship Development and Management
OEC8024	Human Resource Management
OEC8025	Professional Ethics and CSR
OEC8026	Circular Economy
OEC8027	IPR and Patenting
OEC8028	Digital Business Management
OEC8029	Environmental Management

Examination Scheme – B. Tech Semester-VIII

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
EEPEC805Y		20	30	50	1.5	2	100
OEC802Y		20	30	50	1.5	2	100
EEMJP802	Major Project-B	50	--	50	--	--	100
INT801	Internship	50	--	50	--	--	100
Total		**140**	**60**	**200**	--	--	**400**

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

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

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

Curriculum Structure for MDM Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
EEMDM301	Industrial Electronics	3	--	--	3	--	--	3
EEMDM402	Measurements and Control	3	--	--	3	--	--	3
EEMDM503	Electrical Drives and Control	3	--	--	3	--	--	3
EEMDL601	Automation & AI	--	2	--	--	1	--	1
EEMDM604	Automation and Artificial Inteligence	4	--	--	4	--	--	4
	Total	**13**	**2**	**--**	**13**	**1**	**--**	**14**

Examination Scheme for MDM Courses

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
EEMDM301	Industrial Electronics	20	30	50	1.5	2	100
EEMDM402	Measurements and Control	20	30	50	1.5	2	100
EEMDM503	Electrical Drives and Control	20	30	50	1.5	2	100
EEMDL601	Automation & AI	25	--	25	--	--	50
EEMDM604	Automation and Artificial Inteligence	20	30	50	1.5	2	100
	Total	**105**	**120**	**225**	--	--	**450**

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

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

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

F. Syllabi
Third Year

Course Type	Course Code	Course Name	Credits
PCC	EEPCC509	ELECTRICAL MACHINES	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 - Basic Electrical Engineering
2. EEPCC303-Elements of Power System

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct Investigations of Complex Problems
4. PO6: The Engineer and The World
5. PO9: Communication

Course Objectives:

1. Comprehend electromechanical energy conversion in electrical machines.
2. Study analysis of different connections and performance of transformer under different operating conditions.
3. Study Performance and operation of Synchronous motors and Asynchronous motors under different operating conditions.
4. Comprehend Transformation of induction machine voltage equations to direct and quadrature axis variables.

Module	Details	Hrs
	Course Introduction AC machines include transformers and AC rotating machines. Transformers are used to step up or step-down voltage levels in power transmission and distribution systems, ensuring efficient energy transfer. AC rotating machines, such as motors and generators, convert electrical energy to mechanical energy and vice versa, crucial for powering appliances and generating electricity. These machines are essential for electrical power systems, ensuring efficient energy conversion, transmission, and utilization.	**01**
01.	**Fundamentals of Rotating AC Machines** ***Learning Objective:*** *To impart knowledge on the essential basics of rotating AC machines.*	**05-06**
	Content: Recent trends in research and developments in electrical machines, Principle of electromechanical energy conversion. Field energy and mechanical force in a singly excited system. Introduction to doubly excited systems, Double layer	

	lap winding in three phase AC machines, Rotating magnetic field in three phase AC machines.	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply basic concepts of magnetism in electrical machines. (PI-1.3.1)* *LO 1.2: Apply basic electrical and mechanical engineering concepts to interpret the electromechanical energy conversion. (PI-1.4.1)* *LO 1.3: Draw the winding diagram of a double layer lap winding according to the given specifications. (P.I.2.1.2)* *LO 1.4: Analyze the formation of a rotating magnetic field and identify the conditions required for the same. (PI 2.1.3)*	
02.	**Three Phase Transformer**	**07-08**
	Learning Objective: *To comprehend knowledge on the construction and operation of three phase transformers.*	
	Content: Constructional details, Principle of operation, Connections and Phasor (Vector) groups, Parallel operation, Excitation phenomenon in three phase transformer, Oscillating neutral phenomenon, Switching in transient phenomenon.	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental engineering concepts to identify the conditions necessary for any interconnection of transformers. (PI-1.3.1)* *LO 2.2: Apply fundamental electrical engineering concepts to draw phasor diagrams of three phase transformers of different vector groups. (PI-1.4.1)* *LO 2.3: Compare phasor groups of three phasor transformers and find the one which is generally used in distribution side. (PI 2.2.4)* *LO 2.4: Analyze the power sharing through parallel operation and switching in transient phenomenon of three phase transformers. (PI 2.1.3)*	
03	**Three Phase Induction Motor**	**08-10**
	Learning Objective: *To comprehend knowledge on construction and operation of three phase Induction motor.*	
	Content: Constructional details and Principle of operation, Slip, Rotor emf and frequency, current and power, Power stages, Phasor diagram, Equivalent circuit, Torque-speed characteristics in braking, motoring and generating regions, Losses and efficiency, No load and blocked rotor test, Need of starter, Types of starters: Direct On Line (DOL) starter, Autotransformer starter, Star delta starters, Rotor resistance starter, Speed control: Stator voltage control, Frequency control, Concept of soft starter in 3ϕ IM.	

	Learning Outcomes: *Learner will be able to* *LO 3.1: Apply fundamental concepts of electrical engineering to interpret constructional details of 3 phase induction motor. (PI-1.3.1)* *LO 3.2: Apply basic concepts of phasors to draw phasor diagram of 3 phase induction motor for different loading conditions. (PI-1.4.1)* *LO 3.3: Recognize need for starters in induction motor operation and identify suitable one for engineering system. (PI-2.1.2)* *LO 3.4: Determine losses and efficiency of three phase induction motor using suitable test data. (PI-2.1.3)* *LO 3.5: Demonstrate legislation, regulations, codes, and safety standards followed by the industry to manufacture 3 phase I.M. (P.I. 6.1.1) (P.I.6.2.1)* *LO 3.6: Comprehend and integrate practical insights from induction motor observations in the manufacturing industry and produce a clear, well-structured, and well-supported report. (P.I.9.1.2) (P.I.9.2.1)*	
04.	**Single phase Induction Motor**	**07-09**
	Learning Objective: *To study the selection of suitable single phase induction motors for different applications by analyzing its speed-torque characteristics.*	
	Content: Principle of operation, Double field revolving theory, Equivalent circuit of single phase induction motor, Staring methods, Split phase starting- Resistance spilt phase, Capacitor split phase, Capacitor start and run, Shaded pole starting, Applications of single phase IM.	
	Learning Outcomes: *LO 4.1: Apply fundamental concepts of engineering to interpret the constructional details of single phase induction motor. (PI-1.3.1)* *LO 4.2: Apply basic concepts of phasors to draw phasor diagram of different types of single phase induction motor. (PI-1.4.1)* *LO 4.3: Compare characteristics of different single phase induction motors to select suitable one for specific application. (PI-2.2.4)* *LO 4.4: Use double field revolving theory to examine the operation of single phase induction motor during starting and running conditions. (PI-2.4.4)*	
05.	**Synchronous Machines**	**10-11**
	Learning Objective: *To learn constructional details of synchronous machines and analyze their performance under different operating conditions.*	
	Content: Construction, Operation, Winding factor, E.M.F. equation, Armature reaction, Phasor diagrams of cylindrical rotor synchronous generator, No load (OC) and SC test, Voltage regulation, Power flow equations, Parallel operation, Salient pole synchronous generator: Concept of direct and quadrature reactance, Blondel's two reaction theory, Phasor diagram of salient pole machine. **Synchronous Motor:** Principle of operation, Self-starting methods, Phasor diagram, V and Inverted V curves.	
	Learning Outcomes: *Learner will be able to* *LO 5.1: Apply basic concepts of phasors in armature reaction of synchronous machine and phasor diagram for different loading conditions. (PI-1.3.1)* *LO 5.2: Apply fundamental concepts of electrical engineering to interpret constructional details of Synchronous machines. (PI-1.4.1)*	

	LO 5.3: Recognize the need of starting methods for synchronous motors and identify remedies to solve the problem. (PI 2.1.2) *LO 5.4: Determine voltage regulation of synchronous machines using different method. Compare their results and find best method. (PI-2.2.4)* *LO 5.5: Analyze different voltage regulations methods of synchronous generators and state limitations of each one. (P.I.4.3.2)* *LO 5.6: Use O.C., S.C. and Z.P.F. test data of synchronous generator to plot graph showing open circuit, short circuit and zero power factor characteristics and determine voltage regulation by different methods. Analyze voltage regulation obtained by different methods. (P.I.4.3.3)*	
06.	**Modelling of 3 phase induction Machines** ***Learning Objective/s:*** *To impart knowledge on the dynamic modelling of induction machines* **Content:** The ideal induction machine, Voltage equations, Transformation to direct and quadrature axis variables, Basic machine relations in dq variables, Dynamic dq equivalent circuit of induction motor in synchronously rotating reference frame. ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply fundamental knowledge of 3 phase induction motor to draw its primitive model. (P.I.1.4.1)* *LO 6.2 Identify the mathematical knowledge to derive the basic machine relations in dq variables. (PI-2.1.3)* *LO 6.3: Formulate the dynamic dq model of three phase induction motor in synchronously rotating reference frame.(PI-2.3.1)*	**06-07**
	Course Conclusion: Electrical machines are fundamental to the operation of modern electrical systems, from power generation to industrial applications. The knowledge and skills gained in this course provide a solid foundation for understanding and working with these critical components. As technology evolves, the principles learned here will continue to be relevant, forming the basis for future innovations and developments in electrical engineering.	**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.
2.1.3	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 solution processes to select the best process.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

4.3.2 Analyze data for trends and correlations, stating possible errors and limitations.

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

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.

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

9.2.1 Listen to and comprehend information, instructions, and viewpoints of others

Course Outcomes: Learner will be able to

1. Apply fundamental understanding of electromechanical energy conversion and analyse the formation of rotating magnetic fields for efficient machine operation. (LO 1.1, LO 1.2, LO 1.3, LO 1.4)
2. Analyse the operation and performance for various types of connections in three phase transformers. (LO 2.1, LO 2.2, LO 2.3, LO 2.4)
3. Determine the equivalent circuit parameters, formulate the dynamic dq model and analyse the performance characteristics of a 3 phase induction motor. (LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 6.1, LO 6.2, LO 6.3)
4. Analyse the speed-torque characteristics of different types of single phase induction motors and identify the suitable one for specific application. (LO 4.1, LO 4.2, LO 4.3, LO 4.4)
5. Analyse the operating characteristics and performance characteristics of synchronous machines. (LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)
6. Apply safety guidelines and best practices observed during industrial visits and produce a clear, well-structured, and well-supported report based on observations and technical insights gained during an industrial visit.(LO 3.5, LO 3.6)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPC509.1	3	3									
EEPC509.2	3	3									
EEPC509.3	3	3									
EEPC509.4	3	3									
EEPC509.5	3	3		3							
EEPC509.6						3			3		
Average	3	3		3		3			3		

Text Books :

1. Bimbhra P.S., Electric Machinery , Khanna Publisher
2. Bimbhra P.S., Generalized Machine Theory, Khanna Publisher
3. D.P.Kothari, I.J. Nagrath, Electrical Machines, Tata McGraw Hill Education Private Limited

Reference Books :

1. M.G. Say, Performance and Design of Alternating Current Machines, CBS Pub.
2. Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
3. A.E. Fitzgerald, Kingsly, Stephen., Electric Machinery, Tata McGraw Hill

Other Resources :

1. NPTEL Course: Electrical Machines-II By Prof. Krishna Vasudevan, Prof. G. Sridhara Rao, Prof. P. Sasidhara Rao, IIT-Madras Weblink: https://nptel.ac.in/courses/108/106/108106072/
2. NPTEL Course: Electrical Machines By Prof. G. Bhuvaneshwari, Dept. of Electrical Engineering ,IIT-Delhi. Weblink:- https://nptel.ac.in/courses/108/102/10810214
3. NPTEL Course: Electrical Machines-II By Prof. Tapas Kumar Bhattacharya, Dept. of Electrical Engg. ,IITKharagpur. Weblink:- https://nptel.ac.in/courses/108/105/108105131/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

MCQ test strictly as per GATE exam pattern / level): 05 Marks
One Class test: 05 marks
Open book test: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% weightage, and the syllabus covered from MSE to ESE carrying 80% weightage

Course Type	Course Code	Course Name	Credits
PCC	EEPCC510	PROTECTION AND SWITCHGEAR	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 -Basic Electrical Engineering
2. EEPCC408-Power System Engineering
3. EEPCC509-Electrical Machines

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design and development of solution
4. PO6: The Engineer and The World
5. PO11: Life-long learning

Course Objectives:

1. Comprehend the basic principles and concepts of electrical switchgear and protection systems.
2. Study various components of switchgear, such as circuit breakers, relays, fuses, and protective devices.
3. Comprehend different protection schemes used in power systems, including overcurrent, differential, distance, and earth fault protection.

Module	Details	Hrs
	Course Introduction This course provides a comprehensive understanding of the principles, applications, and operation of switchgear and protection systems in electrical power networks. It covers the fundamental concepts and advanced techniques used to ensure the safety and reliability of electrical systems, focusing on the devices and schemes employed to detect and mitigate faults.	**01**
01.	**Introduction to Switchgear:**	**04-06**
	Learning Objective/s: *1. To comprehend the functions, and operation of various substation equipment and switching devices effectively, ensuring safe and efficient electrical power transmission and distribution.* *2. To provide the knowledge necessary to effectively utilize the instrument transformers for accurate measurement and reliable protection in electrical systems.*	
	Contents Switchgear-Definition, Types, Location of switchgear in typical power system, single line diagram to show the measuring and protection scheme Switching Devices- Isolator & Earthing switch (Requirements & definitions, types and construction, Pantograph Isolators, Ratings), Load break switches- Ratings and	

	applications; Contactors- Basic working principle, Terms & Definitions, applications. Instrument Transformers: Introduction to C.T., Potential transformer. Role of instrument transformers in measuring and protection, difference between measuring and protection CTs, selection of technically suitable instrument transformers;	
	Self-Learning Topics: *C.T. and P.T equivalent circuit & Ferro resonance, C.T. saturation and dc offset current*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply electrical engineering concepts to define switchgear functions, create single-line diagrams for protection schemes, and identify isolator and earthing switch requirements. (PI 1.4.1, PI.6.1.1)* *LO1.2: Apply advanced mathematical techniques to model and solve electrical engineering problems in current and potential transformer. (PI 1.1.2)* *LO1.3: Determine design objectives in measuring transformer and functional requirements and arrive at specifications. (PI 3.1.6)* *LO1.4: Recognize the need of selecting suitable CT for the protection purpose. (PI 3.1.1)*	
02.	**Circuit Breakers and Fuses**	
	Learning Objectives: 1. *To analyse the operation, ratings and application of circuit breaker and fuse.* 2. *To Apply industry standards and regulations in the selection and implementation of switchgear and protection equipment.*	**10-12**
	Contents: Circuit Breakers: arc voltage, arc interruption, Re-striking voltage, RRRV, Recovery voltage, resistance switching, interruption of capacitive and inductive current, circuit breaker ratings, classification of C.B, types of CB, L.T. switchgear: - MCB, MCCB, ELCB, HRC fuses, types, construction, characteristics, and application.	
	Self-Learning Topics: *Testing and performance Standards*	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply electrical engineering concepts to understand circuit breakers and fuses, identify switchgear components for public protection, and interpret relevant standards. (PI-1.4.1, PI.6.1.1, PI-6.2.1)* *LO2.2 Apply fundamental engineering concepts to solve the physics of arc phenomena (PI-1.3.1)* *LO2.3 Apply engineering mathematics and computations to analyse arc models in CB. (PI- 2.4.1)* *LO2.4 Identify and analyse existing processes methods for solving the problem of arc quenching in CB and switching capacitive and inductive loads with a CB . (PI-2.2.3)* *LO2.5 Review at least one research paper and applies the knowledge to solve the problems in power system. (PI 11.3.2)*	
03.	**Introduction to Protective relaying**	**08-10**
	Learning Objective:	

	To become acquainted with the operation of different types of relays and their applications within power systems, and to analyze and adjust their settings according to specific applications.	
	Contents: Review of calculation of fault currents, over current protection, desirable qualities of protective relaying, PSM & TSM (Importance, Different types of Time-current characteristics and application), working principle of Electromagnetic Induction disc Relays, Thermal, bimetal relays, Frequency relays, under/over voltage relays, DC relays, Earth fault protection using over current relays, introduction to directional over-current relays, distance protection **,** Working Principle and application of Impedance relay, Causes and remedies of Over reach-under reach, Reactance and Mho relay, Power swing blocking relay.	
	Learning Outcomes: *A learner will be able to* *LO3.1 Identify and analyse causes and effect of fault (PI-2.1.2)* *LO3.2 Analyse different type of time current characteristics and select suitable relay setting for specific application (PI-2.2.3)* *LO3.3 Apply engineering concepts to derive the torque equation for different types of relay. (PI 1.3.1)* *LO3.4Apply Electrical engineering concepts to define the types and operation of various relays. (PI 1.4.1)*	
04.	**Introduction Numerical Relays:**	**04-06**
	Learning Objective: *To comprehend the concepts of electrical engineering to understand the functions of numerical relay, PMU and communication protocols in power systems.*	
	Contents: Numerical relaying fundamentals, sampling theorem, anti-aliasing filters, least square method for estimation of phasors, Implantation of numerical relays. Introduction to the concept of Phase Measurement Unit. Communication protocols in protection systems.	
	Self-Learning Topics: *Static relay, regulatory requirements*	
	Learning Outcomes: *A learner will be able to* *LO4.1 Apply engineering concepts to understand the operation of numerical relay. (PI 1.3.1)* *LO4.2 Apply Electrical engineering concepts to define the functions and operation of various components of Phasor Measuring Unit. (PI 1.4.1)* *LO4.3 Submits a report or delivers a presentation analyzing at least one emerging technology in the field of Numerical Relay/PMUs , including its impact on engineering and society. (PI 11.3.1)*	
05.	**Protection Schemes Provided for major Apparatus:**	**06-08**
	Learning Objective: *To equip protection concepts and choose the appropriate protection mechanism for different components of the power system based on fault types, and to analyse its performance.*	
	Contents:	

	Generators - Stator side (Differential, Restricted Earth fault, protection for 100% winding, Negative phase sequence, Reverse power, turn-turn fault), Rotor side (Field suppression, field failure, Earth fault, turn to turn fault) **Transformers**-Differential protection for star delta Transformer, Harmonic restraint relay, REF protection, Protection provided for incipient faults (Gas actuated relay). **Induction motors -** Protection of motor against over load, short circuit, earth fault, single phasing, unbalance, locked rotor, phase reversal, under voltage, winding temperature, Protection co-ordination	
	Learning Outcomes: *A learner will be able to* *LO5.1 Apply fundamental engineering concepts to understand the causes of faults in power system components (PI-1.3.1)* *LO5.2 Apply basic principles of Electrical Engineering to select suitable protection methods based on faults (PI-1.4.1)* *LO5.3 Identify and analyse existing processes to protect the generator, transformer and induction motor from various faults. (PI-2.2.3)* *LO5.4 Apply engineering mathematics and computations to analyse differential protection's performance for internal and external faults in generator and transformer. (PI- 2.4.1)*	
06.	**Protection of Transmission Lines:**	**05-07**
	Learning Objective/s: *To equip the concepts of protections and select the suitable one for transmission line according to the type of fault and analyse its performance.*	
	Contents: Feeder protection - Time grading, current grading, combined time & current grading protection provided for Radial, Ring Main, Parallel, T- Feeder. Bus Zone Protection - Differential protection provided for different types of bus zones. LV, MV, HV Transmission Lines - Protection provided by over current, earth fault, Differential and Stepped distance protection. EHV & UHV Transmission lines - Type and nature of faults, Need for auto-reclosure schemes, Carrier aided distance protection (Directional comparison method), Power Line Carrier Current protection (Phase comparison method). Introduction to the concept of Islanding	
	Learning Outcomes: *A learner will be able to* *LO6.1 Apply fundamental engineering concepts to understand the causes of faults in transmission line (PI-1.3.1)* *LO6.2 Apply Electrical Engineering concepts to select suitable protection methods based on faults (PI-1.4.1)* *LO6.3 Identify and analyse existing processes to protect a feeder and long transmission line. (PI-2.2.3)* *LO6.4 Apply engineering mathematics and computations to analyse transmission line differential protection. (PI- 2.4.1)*	

	LO6.5 Submits a report or delivers a presentation analyzing at least one emerging technology in the field of transmission line protection, including its impact on engineering and society. (PI 11.3.1)	
	Course Conclusion The study of switchgear and protection systems equips students with the knowledge to ensure the safe and reliable operation of electrical power networks through the effective management of faults and protection schemes, contributing to the stability and efficiency of power systems.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.2	Apply advanced mathematical techniques to model and solve electrical engineering problems
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply electrical engineering concepts to solve engineering problems.
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
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
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
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes:

Learner will be able to

1. Apply basic principles to identify and select the appropriate switching/protecting devices and design measurement schemes while ensuring safety. (*LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyze circuit breaker and fuse concepts to select the appropriate one for a specific application, following standards and ensuring safety. (*LO2.1, LO2.2, LO2.3, LO2.4)*
3. Identify suitable relay and adjust its setting based on application and analyse its operation. (*LO3.1, LO3.2, LO3.3, LO3.4, LO4.1, LO4.2)*
4. Select suitable protection required for power system components and transmission line according to the type of fault and analyse its performance. (*LO5.1, LO5.2, LO5.3, LO5.4, LO6.1, LO6.2, L6.3, LO6.4)*
5. Analyze emerging technologies and their impact on engineering and society while demonstrating independent learning through literature survey and assignments (*LO 2.5, LO4.3, LO6.5)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPCC510.1	3		3			2					
EEPCC510.2	3	3				3					
EEPCC510.3	3	3									
EEPCC510.4	3	3									
EEPCC510.5											3
Average	3	3	3			3					3

Text Books :

1. Switchgear & Protection by Sunil.S.Rao, Khanna Publications
2. Fundamentals of power system protection by Y. G. Paithankar, S. R. Bhide., Prentice hall, India, second edition, 2010.
3. Power system Protection & Switchgear by Badriram Vishwakarma, TMH
4. Power System Protection And Switchgear by Bhuvanesh A O, Nirmal CN, Rashesh PM, Vijay HM, Mc Graw Hill Reference Books:

Reference Books :

1. Fundamentals of protection by Paithanker & Bhide.S.R, P.H.I
2. Static Relays by Madhava Rao, TMH
3. A text book on Power System Engineering by Soni, Gupta, Bhatnagar & Chakraborthi, Dhanpat Rai & Co
4. Protective Relaying by Lewis Blackburn, Thomas.J.Domin
5. Power System Protection by P.M. Anderson, Wiley Interscience
6. Modern Power System Protection – Divyesh Oza, TMH Publication

Other Resources :

1. NPTEL Course: Power System Protection By Prof. S.A. Soman, Dept. of Electrical Engineering, IIT Bombay:- Web link- https://nptel.ac.in/courses/108/101/108101039/
2. NPTEL Course: Power System Protection By Prof. Ashok Kumar Pradhan, Department of Electrical Engineering IIT Roorke, Web link- https://onlinecourses.nptel.ac.in/noc20_ee80/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Quiz based on gate questions: 05 Marks
   - 1 Class test: 05 marks
   - Flip Classroom: 05 marks
   - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
PE	EEPEC5011	ADVANCED POWER ELECTRONICS	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. EEPCC407 - Power Electronics
2. EELBC403 - Power Electronics Lab

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design / Development of Solutions
4. PO5: Engineering tool usage
5. PO8: Individual and Collaborative team work
6. PO9: Communication

Course Objectives:

1. To learn different dc to dc converters and multi-level inverters.
2. To learn the principles of design of magnetics for high frequency transformers and inductors.
3. To model the converter, derive the transfer function of the dc-dc converters and analyse its performance in closed loop.

Module	Details	Hrs	CO
	Course Introduction How advancement of power electronics is a revolutionary field in electrical engineering, how energy efficiency and power density can be improved using power electronic technologies and impact of energy efficiency in various applications of our day to day life.	**01**	--
01.	**Non-Isolated DC-DC Converters**	**09-11**	CO-1
	Learning Objective/s: *Learner will acquire knowledge of various conduction modes of basic dc-dc converters and analyze the operation in various modes.*		
	Contents Comparison of Linear voltage regulators and Switching voltage regulators, Concept of Continuous Conduction Mode (CCM), Boundary & Discontinuous conduction mode (DCM); Parameters affecting conduction mode; Buck, Boost and Buck-Boost converter in Boundary and DCM, identification of conduction mode, derivation of output to input voltage ratio, ripple in inductor current and ripple in capacitor voltage, Numerical Problems, comparison of DCM & CCM operation, introduction to fourth order Cuk converter in CCM and its features.		
	Self-Learning Topics: Other fourth order converters and its features		

	Learning Outcomes: *A learner will be able to* *LO1.1 Apply fundamental engineering concepts to identify the conduction modes and understand the factors affecting the conduction modes. (PI-1.3.1).* *LO1.2 Apply electrical engineering concepts to understand the operation, derive voltage ratio, ripple in inductor current and capacitor voltage of non-isolated converters (PI-1.4.1).* *LO1.3 Identify parameters to select values of energy storage elements of non-isolated dc-dc converters for the given specifications (PI-2.1.2).* *LO1.4 Analyze different conduction modes of non-isolated dc-dc converters to select a suitable mode of operation for an application (PI-2.2.4).*		
02.	**Isolated DC-DC converters** *Learning Objective/s:* *Learner will be able to analyse various isolated dc-dc converters and their features.* Transformer size & frequency, unidirectional and bidirectional core excitation, Flyback converter, Forward converter, Full bridge converter, working, waveforms, derivation of output to input voltage ratio, ripple in inductor current and capacitor voltage, voltage across the switch, numerical problems, comparison and selection of converters for various applications. ***Self-Learning Topics: Nil*** ***Learning Outcomes:*** *A learner will be able to* *LO2.1 Apply fundamental engineering concepts to differentiate various isolated dc-dc converters. (PI-1.3.1).* *LO2.2 Apply electrical engineering concepts to understand the operation, derive voltage ratio, ripple in inductor current and capacitor voltage of isolated converters (PI-1.4.1).* *LO2.3 Identify parameters to select values of energy storage elements of isolated dc-dc converters for the given specifications (PI-2.1.2).* *LO2.1 Analyze different isolated dc-dc converters, compare their features, to select a suitable converter for an application (PI-2.2.4).*	**8-10**	CO1
03.	**Design of Magnetics** *Learning Objective:* *Learner will be able to apply the magnetics concepts to design high frequency inductors and high frequency transformers.* **Contents:** Review of magnetic concepts, ferrite core, area product approach, design steps of high frequency inductor, design of inductor for non-isolated Buck and Boost dc-dc converter and Bidirectional dc-dc converters. Design steps of high frequency transformer, design of high frequency transformer for Flyback dc-dc converter. *Self-Learning Topics: Inductor design of Buck-Boost dc-dc converter* *Learning Outcomes:* *A learner will be able to* *LO3.1 Apply fundamental engineering concepts to derive equations for the design of high frequency magnetics (PI-1.3.1).*	**05-07**	CO2

	LO3.2 Apply electrical engineering concepts to select parameters of high frequency transformer and inductor (PI-1.4.1). *LO3.3 Determine objectives, functional requirements to design a high frequency inductor. (PI- 3.1.6).* *LO3.4 Refine a conceptual design into an appropriate design taking care of the existing practical constraints. (PI-3.4.1).*		
04.	**Modeling of DC-DC Converters** ***Learning Objective:*** *Learner will be able to model DC to DC converters using state space averaging and derive the transfer function using small signal analysis..* **Contents:** State space model of Buck, Boost and Flyback dc-dc converter in CCM, DCM, effect of inductor resistance on the state space models in Buck & Boost converter in CCM, state space averaging technique, small signal analysis, derivation of control to output transfer function for ideal converters and non-ideal converters considering inductor resistance for output voltage regulation, current control etc. ***Self-Learning Topics:*** *State space model of Buck-Boost dc-dc converter.* *Learning Outcomes:* *A learner will be able to* *LO4.1 Apply fundamental engineering concepts to write the state space equations and state space averaged model of DC-DC converters (PI-1.3.1).* *LO4.2 Apply electrical engineering concepts to understand and use small signal analysis in dc-dc converters (PI-1.4.1).* *LO4.3 Extend small signal analysis to derive transfer function of ideal dc-dc converters and inverters (PI-5.1.2).* *LO4.4 Demonstrate the use of modeling techniques for the derivation of the transfer function of converters with non-idealities (PI 5.2.2)*	**06-08**	CO3
05.	**DC-DC Converter Control & Compensator** ***Learning Objective:*** *Learner will be able to select compensator and parameters of feedback control loop of DC to DC converter and analyze the performance.* **Contents:** Objectives of dc-dc converter control, feedback control block diagram, linearized representation of feedback control system, steps to select a compensator based on the transfer function of converter, selection of compensator for Buck, Boost & Flyback dc-dc converters, selection of compensator parameters, analysis of closed loop performance of converter analytically or by Bode plots or any other suitable method. ***Self-Learning Topics: Selection of compensator for Buck-Boost converter*** *A learner will be able to* *LO5.1 Apply fundamental engineering concepts to understand the control objectives of and feedback control of dc-dc converter (PI-1.3.1)*	**06-08**	CO4

	LO5.2 Apply electrical engineering concepts to understand the linearized feedback control of the converter (PI-1.4.1). *LO5.3 Determine objectives, functional requirements to select and design a compensator (PI- 3.1.6).* *LO5.4 Refine the compensator design taking care of feedback control objectives. (PI-3.4.1).* *LO5.5 Collaborate to analyse the given requirements of the dc-dc converter, select compensator parameters for a given application and demonstrate effective communication (8.2.1,9.3.1).* *LO5.6 Present the findings of the analysis of converter closed loop performance individually or as a team. (8.3.1,9.3.2).*		
06.	**Inverter Modeling and Multi-Level Inverters** ***Learning Objective/s:*** *To demonstrate the knowledge to model an inverter and analyse the features of multilevel inverter and its modulation schemes.* **Contents:** Introduction to inverter modeling: AC-side control model of half bridge inverter, full bridge inverter, Control block diagram of the closed-loop of half-bridge & full bridge inverter system. Draw backs of conventional inverters for medium voltage applications, multi-level concept, types of multilevel inverters: Diode clamped, flying capacitor and cascaded MLI, operation and switching sequence; Phase shifted and level shifted PWM techniques for MLI, Applications and selection of MLI for an application. ***Learning Outcomes:*** *A learner will be able to* *LO6.1 Apply fundamental engineering concepts to analyze and solve the issues of conventional inverter when used for medium voltage application (PI-1.3.1).* *LO6.2 Apply electrical engineering concepts to model conventional inverter and analyze the closed loop operation (PI-1.4.1, PI 5.2.2).* *LO6.3 Analyze the operation of various Multi-level inverters (PI-2.1.2).* *LO6.4 Analyze the modulation schemes and compare them to select a suitable method for the MLI (PI-2.2.4).*	**04-06**	CO5
	Course Conclusion Course will conclude by addressing the need for several advanced power electronic converters, modeling of converters and magnetics design. Emphasizing that how advanced power electronics play a crucial role in the development of energy efficient technologies and systems with lesser foot print.	**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

2.2.4	Compare alternative solution processes to select the best process
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 tools and models
3.1.6	Determine design objectives, functional requirements and arrive at specifications.
3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
5.1.2	Extend 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	Produce clear, well-constructed, and well-supported written engineering documents
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations

Course Outcomes:

Learner will be able to

1. Apply fundamental knowledge to identify the conduction mode and analyse the operation of dc-dc converters. (LO1.1, LO1.2, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4)
2. Identify parameters to select the value of energy storage elements and design high frequency inductors and transformers for dc to dc converters. (LO3.1, LO3.2, LO3.3, LO3.4)
3. Model power electronic converter by applying modern tools or techniques to derive the transfer function of the converter. (LO4.1, LO4.2, LO4.3, LO4.4,LO6.2)
4. Select and design a compensator for the converter to meet the control objectives, analyse the closed loop performance and present the findings. (LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO5.6)
5. Analyse multi-level inverters and modulation schemes of Multilevel inverter suitable for power conversion applications. (LO6.1, LO6.2, LO6.3, LO6.4)

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC5011.1	3	3									
EEPEC5011.2	3		3								
EEPEC5011.3	3				3						
EEPEC5011.4	3		3					3	3		
EEPEC5011.5	3	3									
Average	3	3	3		3			3	3		

Text Books:

1.	N. Mohan, T. M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design", John Wiley & Sons.
2.	L. Umanand, S.R. Bhat, "Design of Magnetic Components for switched Mode Power Converters", New Age International Publishers.
3.	Joseph Vithayathil, "Power Electronics: Principles & Applications", McGraw Hill.
4.	A.Yazdani R. and Iravani, VOLTAGE-SOURCED CONVERTERS IN POWER SYSTEM, Modeling, Control and Applications, Wiley, IEEE Press.
5.	M. H. Rashid, "Power Electronic: Circuits, Devices & Applications", Pearson education.
6.	Daniel W. Hart, "Power Electronics", Mc Graw Hill.
Reference Books :	
1.	Simon Ang, A. Oliva, "Power Switching Converters, CRC Press, Taylor & Francis group.
2.	M. H. Rashid, "Hand book of Power Electronics", PHI.
3.	L. Umanand, "Power Electronics: Essentials & Applications", Wiley.
4.	Bin WU, "High–Power Converters and AC Drives", IEEE Press, Wiley Inter-Science.
5.	V. Ramanarayanan , "Course Material on Switched Mode Power Conversion" , IISc Bangalore.
Other Resources :	
1.	NPTEL Course: Advance power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee28/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
    - Development of Working model for demonstration of concept (10marks)
    - Report writing/Public speaking: 05 marks
    - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
PE	EEPEC5012	ENGINEERING ELECTROMAGNETICS	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. BSC101- Engineering Mathematics-I
2. ESC102 -Basic Electrical Engineering
3. BSC205 - Engineering Physics-II

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Modern tool usage
4. PO8: Individual and team work
5. PO11: Life-long learning

Course Objectives :

1. Comprehend the basic principles and concepts of electromagnetic vector fields.
2. Recognize and describe various elements of electrostatics and magneto statics.
3. Comprehend problems relating to electromagnetic fields.

Module	Details	Hrs
	Course Introduction This course provides a comprehensive understanding of the principles, applications, and operation of Electromagnetic fields and waves, which form the backbone of modern technology from communications to energy transmission. Understanding the principles of Maxwell's equations, the nature of EM waves, and their wide-ranging applications helps us harness their power for diverse purposes, from medical imaging to wireless data transfer. The operation of EM waves is fundamental in both practical engineering and theoretical physics, influencing everything from basic electronics to advanced space technologies.	**01**
01.	**Introduction to Vector Basics**	**05-07**
	Learning Objective/s: *To furnish and comprehend the basic mathematical concepts related to electromagnetic vector fields.*	
	Contents Introduction to Vectors Calculus, Rectangular, Cylindrical and Spherical Co-ordinate System, Co-ordinate and vector transformation. Numerical on line, Surface and Volume Integrals.	
	Self-Learning Topics: *Enlist applications*	
	Learning Outcomes:	

	A learner will be able to *LO1.1: Apply vectors calculus to solve problems. (1.1.1)* *LO1.2: Identify the location of point in rectangular, cylindrical, and spherical co-ordinate system (2.1.3)* *LO1.3: Apply co-ordinate system and vector transformation for a given situation. (1.3.1)* *LO1.4: Interpret and solve numerical on line, Surface and Volume Integrals (2.4.1)*	
02.	**Electrostatics**	**9-11**
	Learning Objectives: 1. *To comprehend problems relating to electric field and electric potential by applying the principles of electrostatics.* 2. *To teach an application using suitable simulation tool.*	
	Contents: Coulomb's Law in Vector Form, Electric Field Intensity, Definition, Principle of Superposition, Electric Field due to point charges, Electric Field due to line charge , Electric Field due to an infinite uniformly charged sheet, Definition and physical interpretation of gradient, Electric scalar potential	
	Self-Learning Topics: Relationship between potential and electric field and its application on Surface voltage gradient on conductor.	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply fundamental concepts of electrostatics in vector form (1.3.1)* *LO2.3Apply electric field due to point charges and derive electric field for the specified charge configuration and analyze the electric field. (1.4.1)* *LO2.4 Analyze electric field due to point charges and derive electric field for the specified charge configuration and analyze the electric field. (2.1.3)* *LO2.5 Identify physical interpretation of gradient and derive Electric scalar potential, Relationship between potential and electric field and analyze the electric field. (2.2.1)* *LO2.6 Demonstrate application of simulation software FEMM for electrostatic field in team activity. (5.1.2,5.2.2,8.1.1,8.3.1)*	
03.	**Magnetostatics**	**07-09**
	Learning Objective: 1. *To comprehend problems relating to magnetic field , magnetic energy density and magnetic potential by applying the principles of magnetostatics.* 2. *To teach an application using suitable simulation tool.*	
	Contents: Biot-Savart's Law in vector form, Magnetic Field intensity due to a finite and infinite wire carrying a current I, Magnetic field intensity on the axis of a circular loop carrying a current I, Ampere's circuital law and its application on A solid cylindrical conductor and Infinitely long coaxial transmission line, Magnetic flux density, Definition and physical interpretation of Curl, Magnetic Vector Potential. Numerical	
	Self-Learning Topics: *The Lorentz force equation for a moving charge and its applications on Force on a wire carrying a current I placed in a magnetic field*	
	Learning Outcomes: *A learner will be able to*	

	LO3.1 Apply Biot-Savart's Law in vector form for the electromagnetic field .(1.3.1) *LO3.2 Analyze the magnetic field intensity due to wire carrying a current and relate with magnetic field intensity. (1.4.1)* *LO3.3 Analyze the magnetic field intensity due to a finite and infinite wire carrying a current and derive magnetic field intensity and apply Curl for different magnetic field parameters. (2.1.3)* *LO3.4Analyze Lorentz force equation for a moving charge and its applications on Force on a wire carrying a current placed in a magnetic field (2.2.1)* *LO3.5 Demonstrate application of simulation software like FEMM for magneto static field in team activity. (5.1.2,5.2.2,8.1.1,8.3.1)*	
04.	**Electric and Magnetic Fields in Materials**	**03-05**
	Learning Objective: *To furnish and comprehend electrostatic and magneto static boundary conditions to understand the effect of material medium on electric and magnetic fields*	
	Contents: Poisson's and Laplace's equation, Electric Polarization, Electric current, Current density, Point form of ohm's law, Continuity equation for current. Numerical.	
	Self-Learning Topics: *Electric polarization in dielectric material*	
	Learning Outcomes: *A learner will be able to* *LO4.1 Apply Poisson's and Laplace's equation for the specified field and visualize electric polarization (1.1.1)* *LO4.2Analyze Poisson's and Laplace's equation for the specified field and visualize electric polarization (1.3.1)* *LO4.3 Analyze Continuity equation for current and apply for Kirchhoff's Current Law (2.1.3)* *LO4.4Analyze Continuity equation for current and apply for Kirchhoff's Current Law (2.4.1)*	
05.	**Electromagnetic Fields**	**07-09**
	Learning Objective: *To furnish and teach the concepts related to Faraday's law, induced emf and Maxwell's equations.*	
	Contents: Faraday's law, Maxwell's Second Equation in integral form from Faraday's Law, Equation expressed in point form, Displacement current, Ampere's circuital law in integral form, Modified form of Ampere's circuital law as Maxwell's first equation in integral form, Equation expressed in point form, Maxwell's four equations in integral form and differential form. Numerical	
	Self-Learning Topics: *Boundary condition at interface*	
	Learning Outcomes: *A learner will be able to* *LO5.1 Apply time varying Electric and Magnetic Fields under different conditions and demonstrate the ability to apply it.(1.4.1, 11.1.2)*	

	LO5.2 Identify assumptions in Maxwell's laws and demonstrate for the given dielectric medium and demonstrate the ability to apply. (2.2.3, 11.1.1,11.1.2)	
06.	**Electromagnetic Wave Theory**	**06-08**
	Learning Objective/s: *To furnish the concepts of Maxwell's equations for the uniform plane waves and develop the ability to analyze the electromagnetic wave.*	
	Contents: Electromagnetic Wave theory: Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in phasor form, Wave equation in phasor form. (No numerical)	
	Learning Outcomes: *A learner will be able to* *LO6.1 Apply electromagnetic wave theory to derive of electromagnetic wave equation (1.4.1)* *LO6.2 Analyze electromagnetic wave theory to derive of electromagnetic wave equation (2.1.3)* *LO6.3 Identify and analyze uniform plane waves for different media and demonstrate the ability to apply it. (2.2.3, 11.1.1,11.1.2)*	
	Course Conclusion Electromagnetic fields and waves are fundamental to understanding the behavior of electric and magnetic phenomena in various media. Their study bridges the gap between classical physics and modern technological applications for unified nature of fields ,Maxwell's Equations and boundary conditions.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques such as calculus, linear algebra and statistics to solve problems
1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub-problems.
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
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools
9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
11.1.1	Describe the rationale for the requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap.

Course Outcomes:
Learner will be able to

1. Apply the basic mathematical concepts to analyse the electromagnetic vector fields.*(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyse problems relating to electric field by applying the principles of electrostatics. *(LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)*
3. Apply the principles of magneto statics to analyse problems relating to magnetic fields. *(LO3.1, LO3.2, LO3.3, LO3.4)*
4. Use appropriate tool like FEMM to simulate and analyse results in a team based activity.(*LO2.5,LO3.5)*
5. Apply the concepts related to Maxwell's equations to time varying electromagnetic fields.*(LO5.1,LO5.2)*
6. Apply the knowledge of Maxwell's equations to get electromagnetic waves in real life situation. *(LO6.1, LO6.2)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPE5012.1	3	3									
EEPE5012.2	3	3			3			3			
EEPE5012.3	3	3			3			3			
EEPE5012.4	3	3									
EEPE5012.5											3
EEPE5012.6											3
Average	3	3			3			3			3

Text Books :

1. W. Hayt, "Engineering electromagnetic", McGraw Hill, 4th edition, 1987.
2. Edminister, "Schaum"s series in electromagnetic" McGraw Hill publications, 3rd edition, 1986.
3. M.N.O.Sadiku, "Elements of Engineering Electromagnetics" Oxford University Press, 3rd Ed.

Reference Books :

1. N. Narayan Rao, "Elements of Electromagnetic", PHI publication, 4th edition, 2001.
2. David K.Cherp, "Field and Wave Electromagnetics - Second Edition-Pearson Edition

Other Resources :

1. NPTEL Course: Electromagnetic Fields By Prof. Harishankar Ramachandran, Department of Electrical Engineering IIT Madras :-Web link- https://nptel.ac.in/courses/108/106/108106098/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)

- Quiz based on gate questions: 05 Marks
- 1 Class test: 05 marks
- Flip Classroom: 05 marks
- Regularity and Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credit
PE	EEPEC5013	ELECTRIC VEHICLE TECHNOLOGY	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- Basic Electrical Engineering
2. ESC203- Basic Electronics Engineering
3. EEPCC407- Power Electronics

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. PO6: The engineer and The World

Course Objectives:

1. To develop the ability to evaluate and compare the performance metrics and environmental impacts of Internal Combustion Engine (ICE) and Electric Vehicle (EV) drivetrains.
2. To determine the optimal EV motor power requirements, considering performance specifications, vehicle dynamics, and drivetrain configurations.
3. To analyse battery pack requirements and design principles for Electric Vehicles (EV) application.
4. To synthesize the inherent control features in Electronic Control Units (ECUs) utilized in Electric Vehicles (EVs)
5. To identify and implement Functional Safety requirements specific to Automotive Electronics in Electric Vehicles (EVs).

Module	Details	Hrs
	Course Introduction In recent years, the automotive industry has experienced a significant paradigm shift towards sustainable transportation solutions, driven by concerns over environmental pollution, energy security, and climate change. The journey towards sustainable mobility began with the introduction of hybrid vehicles, which served as a bridge between conventional gasoline-powered cars and fully electric propulsion systems. In this era of electric mobility, innovation is rapidly transforming electric vehicle technology. With advancements like autonomous driving, vehicle-to-grid integration, and smart charging, electric vehicles are set to revolutionize transportation. Upon completion of the Electric Vehicle Technology course, students will have a thorough understanding of the intricacies of e-mobility.	**1-2**
01.	**Drivetrain: Internal Combustion Engine and Electric Vehicle** ***Learning Objective/s:***	**6-7**

	To compare and evaluate the performance of Internal Combustion Engine (ICE), Hybrid Electric Vehicle (HEV), and Electric Vehicle (EV) drivetrains.	
	Contents:	
	Fundamentals of Internal Combustion Engine (ICE) Drivetrains; Electric Vehicle (EV) Drivetrains, Hybrid EV drivetrains; comparison of performance between ICE and EV drivetrains, factors affecting acceleration, torque, and efficiency in ICEs and EVs, evaluation of energy efficiency, environmental impact analysis, cost comparison, technological advancements and market trends.	
	Self-Learning Topics: *Understanding the working principles of internal combustion engines, types and components*	
	Learning Outcomes: *A learner will be able to* *LO1.1 Demonstrate understanding of the fundamental principles and operating mechanisms of ICE, EV, and Hybrid EV drivetrains (P.I.-1.3.1)* *LO1.2 Apply engineering concepts to plot the performance characteristics of ICE, EV, and hybrid drivetrains (P.I.-1.4.1)* *LO1.3 Identify trade-offs between performance, efficiency, cost, and environmental impact while selecting ICE, EV, or hybrid drivetrains, and suggest sustainable solutions for improving vehicle design and usage. (P.I.-6.3.2, PI-11.2.1)*	
02.	**Electric Motors for EVs**	**6-7**
	Learning Objective/s: *To analyze and integrate electric motor with their control algorithms into EV drivetrain for optimized performance and functionality.*	
	Contents:	
	Overview of electric motor types commonly used in EV drive trains: AC induction motors, permanent magnet synchronous motors, Switched Reluctance motors and brushless DC motors, comparison of motor characteristics, performance, and efficiency; Motor control algorithms: field-oriented control (FOC), direct torque control (DTC); Integration of electric motors into vehicle architecture and drive train systems.	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply engineering knowledge to identify and differentiate commonly used electric motor types in EV drivetrains (P.I.-1.4.1)* *LO2.2 Identify and apply design criteria and methodologies to optimize the efficiency, power output, and thermal management of electric motors in EV drivetrain (P.I.-3.1.6)* *LO2.3 Identify integration challenges and give solutions to address the challenges of electric motors in EV drivetrain. (P.I.-3.2.3, PI-11.2.1)* *LO2.4 Identify the role of engineers in optimizing EV drivetrains by considering safety, thermal management, and weight distribution to protect public interest. (P.I.-6.1.1)*	
03.	**Energy Storage and Battery Technologies:**	**5-6**
	Learning Objective/s: *To analyze battery chemistry, pack design, safety considerations, and optimization strategies to enhance electric vehicle performance and reliability.*	
	Contents:	
	Battery chemistry fundamentals: Lithium-ion, Solid-state, Nickel-Metal Hydride and emerging technologies. Battery pack design, Battery Management Systems (BMS), safety considerations, energy efficiency and range optimization. Selection and sizing of fuel cell for FCEV, battery-ultra-capacitor hybrid.	

	Learning Outcomes: *A learner will be able to* *LO3.1 Apply knowledge of engineering and evolving technologies to identify principles, characteristics, and safety considerations of various battery chemistries used in electric vehicles (P.I.-2.1.2, PI-6.1.1, PI-11.2.1)* *LO3.2 Determine design objectives and specify battery pack configurations for electric vehicles, considering cell arrangement, thermal management, and structural integrity. (P.I.-3.1.6, PI-11.2.1)* *LO3.3 Identify and implement safety features and protocols in EV battery systems to address risks and ensure protection of public interest. (P.I.-3.1.5, PI-6.1.1)*	
04.	**Automotive Subsystem and System Integration**	**5-6**
	Learning Objective/s: *To analyze the essential architecture, control features, communication protocols, design considerations specific to Electronic Control Units (ECUs), for Electric Vehicles (EVs).*	
	Contents:	
	Electronic Control Unit (ECU): Control Features, Communications between ECUs. Acceleration and braking control, regenerative braking. EMC design on ECU level, EMC design on system level radiated emissions and conducted emissions, EMI EMC measurements. EV chargers and their types, architecture, design considerations for charger, charging protocols and standards.	
	Learning Outcomes: *A learner will be able to* *LO4.1 Identify the role of various sensors, actuators, and control algorithms in ECU operation. (P.I.-2.1.2)* *LO4.2 Synthesize design considerations for Electromagnetic Compatibility (EMC) by reviewing state-of-the-art practices and understanding the engineer's role in ensuring safe interaction between vehicle components. (P.I.-3.1.3, P.I.-6.1.1)* *LO4.3 Determine design specifications for Electric Vehicle (EV) chargers with attention to efficiency, compatibility, and compliance with safety standards and regulations. (P.I.-3.1.6, P.I.-6.2.1)* *LO4.4 Identify existing solution methods and justify the importance of interoperability and standardization to support large-scale EV adoption and infrastructure development. (P.I.-2.2.3)*	
05.	**Functional Safety of Automotive Electronics:**	**4-5**
	Learning Objective/s: *To investigate functional safety standards and assure compliance of safety to mitigate hazards in diverse automotive scenarios.*	
	Contents:	
	Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262, Energy Storage integrity / protection, Hazard and Risk Analysis (HARA) for different situations, testing of vehicles for compliance of safety norms.	
	Learning Outcomes: *A learner will be able to* *LO5.1 Identify functional safety requirements for automotive systems based on state-of-the-art practices and evolving technological trends. (P.I.-3.1.3, PI-11.2.1)* *LO5.2 Apply ISO 26262 principles and extract safety requirements from relevant codes and standards to develop and validate safety-critical automotive systems. (P.I.-6.2.1 & P.I.-3.1.4)*	
06.	**Electric Vehicle System Design:**	**8-10**

	Learning Objective/s: *Analyse design considerations for 2W and 4W EVs.*	
	Contents:	
	Design considerations for 2W and 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit, Vehicle Power Demand during Driving Cycles, EV motor power requirement, Battery pack sizing.	
	Learning Outcomes: *A learner will be able to* *LO6.1 Determine design objectives and functional requirements for Electric Vehicles (EVs), considering varying road conditions and driving scenarios, based on state-of-the-art engineering practices. (P.I.- 3.1.6)* *LO6.2 Identify key design factors impacting EV performance, including vehicle dynamics, driving range, battery charging requirements, user experience, and safety, while ensuring compliance with relevant regulations and staying updated with technological advancements. (P.I.-3.1.6, P.I. 6.2.1, PI-11.2.1)*	
	Course Conclusion	**1-2**
	By the end of the program, students will have acquired the skills and comprehensive understanding of the fundamental principles of complete lifecycle of electric vehicles, including their inception, design, development, and advanced systems which is necessary to tackle the complexities of this emerging industry.	
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 engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
3.1.3	Synthesize engineering requirements from a review of the state-of-the-art
3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.3	Identify suitable criteria for the evaluation of alternate design solutions
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
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current

Course Outcomes:

1. Apply appropriate performance metrics and assess environmental implications to differentiate between Internal Combustion Engine (ICE) and Electric Vehicle (EV) drivetrains.*(LO1.1, LO1.2, LO2.1)*

2. Integrate design considerations to determine EV motor power and battery capacity requirements based on performance specifications, vehicle dynamics, and drivetrain configuration. *(LO2.3, LO3.1, LO5.1, LO5.2)*
3. Analyse battery pack and motor design principles to enhance efficiency, thermal management, and structural integrity in Electric Vehicles (EVs). *(LO2.2, LO2.3, LO3.2, LO3.3, LO6.1)*
4. Identify Electronic Control Unit (ECU) functionalities to optimize control and performance in Electric Vehicle (EV) systems. *(LO4.1, LO4.4)*
5. Ensure ISO 26262 compliance in Automotive Electronics by implementing functional safety principles, risk mitigation strategies and sustainable design practices. *(LO1.3, LO2.4, LO3.3, LO4.2, LO4.3, LO5.2, LO6.2)*

CO-ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPE5013.1	3										
EEPE5013.2		3	3			3					3
EEPE5013.3			3								3
EEPE5013.4		3									
EEPE5013.5			3			3					3
Average	**3**	**3**	**3**			**3**					**3**

Textbooks:

1. Electric Vehicle Technology Explained by James Larminie and John Lowry, 1st Edition, 2012, Wiley
2. Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Husain, 1st Edition, 2023, CRC Press
3. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design
   by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi., 1st Edition, 2004, CRC Press

Reference Books:

1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
2. Electric Vehicle Machines and Drives Design, Analysis and Application by K. T. Chau, 2015, IEEE Press and Wiley
3. Energy Management Strategies for Electric and Plug-in Hybrid Vehicles by Sheldon Williamsom, 2013, Springer
4. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, 2018, IET

Other Resources:

1. NPTEL Web Course: Electric Vehicles - Part 1 by Prof. Amit Kumar Jain D IIT Delhi.
2. NPTEL Web Course: Fundamentals of Electric vehicles: Technology & Economics, by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras.
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati

In-semester assessment (50 marks)

1. Continuous Assessment (20 Marks)
   Suggested breakup of distribution

Assignment on live problems/ case studies, wherein problems are given prior.
Students are expected to research and collect required resources.
They can use the resources and solve the problem on assigned date and time in Institute premises in presence of faculty member. :10 marks
Think-pair-share worksheets/ Mind mapping/Flip classroom: 05 marks
Regularity & Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)
   Mid semester examination will be based on 30% - 40% 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
LC	EELBC506	SWITCHGEAR AND SAFETY LAB	01

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. EEPCC303 - Elements of Power System
2. EEPCC408 - Power System Engineering
3. EEPCC510 - Protection and Switchgear

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Modern Tool Usage
4. PO6: The Engineer and The World:
5. PO8: Individual and team work
6. PO11: Life long learning

Course Objectives:

1. To impart the knowledge on concepts of different protection schemes and their application in power system
2. To impart the knowledge on operation of different Fuses, Contactor and circuit breaker
3. To impart the knowledge on the concept of earthing and its applications in power system

Module	Details	Hrs
	Course Introduction Switchgears are the most important components of electrical power system. They provide protection as well as safety to the system. Hence, it is very essential to understand the switchgear equipment and their operation.	
01.	**Protective Devices in Power System**	**06**
	Learning Objective: *To impart knowledge on various components and operation of Fuses and Contactor, MCB, MCCB and Air circuit breaker as a team.*	
	Theme for conducting experiment: **1.** To identify various components and analyse operation of different Fuses, Contactor, MCB, MCCB and Circuit breakers for power system protection ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Identify, assemble various components to analyse the operation of Fuses, Contactor, MCB, MCCB and Circuit breakers for the power system protection, recognize the need for protective devices using technical literature, engineering roles for protection of the public and safety while demonstrating effective communication as individual and present results as a team (PI-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
02.	**Characteristics of Relays**	**08**
	Learning Objective: *To develop skill for performing experiment on overcurrent, over voltage by using Induction Disc relay, Numerical relay and static relay as a team*	

	Theme for conducting experiment: **2.** To identify and analyse characteristics of Induction Disc relay, Static relay and Numerical relay for overcurrent protection and overvoltage protection with different TSM and PSM setting ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Identify, and evaluate information for demonstrating over current and over voltage relay operation, conduct experiments using appropriate procedures, tools and technique, recognise new developments in field with effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 4.1.1, 4.3.1, 8.2.1,8.3.1, 11.2.2, 11.3.1)*	
03.	**Protection Schemes**	**06**
	Learning Objective: ***To study different protection schemes for transformer, Induction motor, transmission line and busbar.***	
	Theme for conducting experiment: **3.** To identify and analyse different protection schemes like protection against overload, locked rotor, single phasing of three-phase Induction motor. ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Identify and analyze protection schemes of three-phase Induction motor for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
	Theme for conducting experiment: **4.** To perform differential protection for a three phase transformer. ***Learning Outcomes:*** *A learner will be able to* *LO 3.2: Identify and analyze protection schemes of transformer for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
	Theme for conducting experiment: **5.** To perform distance protection in transmission line. ***Learning Outcomes:*** *A learner will be able to* *LO 3.3: Identify and analyze protection schemes of transmission line for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
	Theme for conducting experiment: **6. To perform simulation for protection of transformer, Induction motor, transmission line and busbar.** ***Learning Outcomes:*** *A learner will be able to* *LO 3.4: Identify modern engineering tools, modeling and analysis for protection of electrical equipment demonstrating effective communication as individual and present results as a team. (P.I.-5.1.1 5.1.2, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	

04.	**Safety of Electrical Systems** **Contents:** Study the various types of earthing for electrical systems, Code of practice for earthing. ***Learning Objective:*** *To teach type of earthing system and analyze earth resistance for a given system using code and standards.*	**04**
	Theme for conducting experiment: **7.** To identify earthing system and measure earth resistance using Digital Earth Resistance Tester ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Identify type of existing earthing system, measure earth resistance, recognize the need for earthing system for protection of the public and safety using technical literature and demonstrate effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
	Theme for conducting experiment: **8.** To demonstrate operation of ELCB for protection of the public and safety by suitable earthing system. ***Learning Outcomes:*** *A learner will be able to* *LO 4.2:Demonstate the operation of ELCB, recognize the need for earthing system for protection of the public and safety using technical literature and demonstrate effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)*	
	Theme for conducting experiment: **9.** Industrial visit to switchgear manufacturing company, substation visit or load dispatch centre etc (report based on actual field Visit) ***Learning Outcomes:*** *A learner will be able to* *LO 4.3: Demonstrate effective communication as individual and present reports as a team for an Industrial visit (PI. 8.2.1,.8.3.1)*	
	Minimum 2 experiments from each module and Industrial visit	

Performance Indicators:

P.I. No.	P.I. Statement
2.2.2	Identify, assemble and evaluate information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
4.1.1	Define a problem, its scope and importance for purposes of investigation
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
5.1.1	Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level

6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

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

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

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

Course Outcomes:

Learner will be able to

1. Identify and analyse the functioning of various components and assemble Fuses, MCB, MCCB and Circuit breakers for power system protection using technical literature *(LO1.1).*
2. Identify and analyse methods to conduct experiments on over current and over voltage relay operation *(LO2.1).*
3. Identify and analyse protection schemes for transformer, Induction motor, transmission line and busbar using modern engineering tools *(LO 3.1, LO 3.2)*.
4. Identify existing earthing system and solutions for protection of given power system and report on the technical data *(LO4.1, LO4.2).*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELC506.1		3				3		3			3
EELC506.2		3		3				3			3
EELC506.3		3			3	3		3			3
EELC506.4		3				3		3			3
Average		3		3	3	3		3			3

Text Books:

1. Switchgear & Protection by Sunil.S.Rao, Khanna Publications
2. Switchgear by Badriram Vishwakarma, TMH
3. Power system Protection & Power System Protection And Switchgear by Bhuvanesh A O, Nirmal CN, Rashesh PM, Vijay HM, Mc Graw Hill

Reference Books:

1. Fundamentals of protection by Paithanker & Bhide.S.R, P.H.I
2. Static Relays by Madhava Rao, TMH.

Other Resources:

1. NPTEL Course: Power System Protection By Prof. S.A. Soman, Dept. of Electrical Engineering, IIT Bombay:- Web link- https://nptel.ac.in/courses/108/101/108101039/
2. NPTEL Course: Power System Protection and Switchgear By Prof. Bhaveshkumar Bhalja, Dept. of Electrical Engg, IIT Roorkee:- Web link- https://nptel.ac.in/courses/108/107/108107167/

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Practical Exercises- 10 Marks
- Oral Test– 05 Marks
- Regularity and active participation - 05 Marks
- Industrial Visit: Students' visit to be arranged to the nearby industry involved in design/ manufacturing/ processing in the following electrical engineering domains: Electrical Switchgears / Electrical Substation. All students shall submit visit report in appropriate format as a part of the submission (05 marks).

END SEMESTER ASSESSMENT (Practical and Oral Examination) (25 Marks)

- Two examiners, one Internal and one External will do the evaluation.
- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections/simulation and take readings. The examiners verify the connections and output. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Course Type	Course Code	Course Name	Credits
LBC	EELBC507	ELECTRICAL MACHINES LAB	01

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. ESC102-Basic Electrical Engineering
2. EELBC302-Electrical System Lab
3. EEPCC509-Electrical Machines

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering Tool usage
4. PO8: Individual and team work
5. PO11:Lifelong learning

Course Objectives:

1. Comprehend effect of change of load on the performance of Synchronous and Asynchronous motor.
2. Study analysis of different types of connections of three phase transformer.
3. Comprehend voltage regulation of synchronous generator by performing suitable tests.
4. Impart knowledge on analysis of synchronous motor performance under various operating conditions.

Module	Detailed Contents	Hrs
	Course Introduction	
01.	**Three Phase Transformer:** ***Learning Objective:*** *To study the performance of performance of Three phase transformer under different operating conditions and for different types of connections.*	**08**
	Theme for conducting Experiment: 1. Determine equivalent circuit parameters of three phase transformer. ***Learning Outcome:*** *A learner will be able to* *LO 1.1: Identify appropriate meters to perform O.C. and S.C. test on 3 phase transformer and determine different parameters by performing experiment as a team. (P.I. 2.1.2) (P.I. 4.1.3) (P.I.8.1.1) (P.I.11.2.2)*	

	Theme for conducting Experiment: 2. Analyze Scott and Open delta connection of three phase transformer. ***Learning Outcome:*** *A learner will be able to* *LO 1.2: Demonstrate objective and limitation of the Scott Connection and Open delta connection of three phase transformer as a team. (P.I. 2.4.4) (P.I.8.2.2) (P.I.11.3.2)*	
	Theme for conducting Experiment: 3. Analyze phasor relationship when three similar transformers are connected to form three phase transformers of different phasor groups. ***Learning Outcome:*** *A learner will be able to* *LO 1.3: Connect the given three similar transformers to form three phase transformers of different phasor groups and establish a relationship between measured data and underlying physical principles of Three phase transformer. (P.I. 2.4.4) (P.I.4.3.3) (P.I.11.2.2)*	
02.	**3-Phase Induction Motors:** ***Learning Objective:*** *To comprehend the performance characteristics of 3 phase induction motors by performing different tests.*	**10**
	Theme for conducting Experiment: 4. Analyze effect of load on the performance of three phase squirrel cage/slip ring induction motor. ***Learning Outcome:*** *A learner will be able to* *LO 2.1: Identify effect of change in the load on different parameters of 3 phase Induction motors and represent results/ readings using norms of practice of*	
	Theme for conducting Experiment: 5. Determine the equivalent circuit parameters of three phase induction motor by conducting appropriate tests. ***Learning Outcome:*** *A learner will be able to* *LO 2.2: Determine losses using readings of O.C.- S.C. test data of three phase induction motor and separate them. Also determine equivalent circuit parameters and draw circle diagram to analyse its performance implementing norms of practice. (PI 2.1.2) (P.I. 2.2.2) (P.I. 8.1.2) (P.I.4.3.3) (P.I.11.3.1)*	
	Theme for conducting Experiment: 6. Demonstrate different types of starting and braking methods of IM. ***Learning Outcome:*** *A learner will be able to* *LO 2.3: Demonstrate as a team use of different starters and braking methods of three phase induction motor. (P.I. 2.1.1) (P.I.2.4.4) (P.I.8.3.1) (P.I.11.3.1)*	

	Theme for conducting Experiment: 7. Analyze speed control techniques of three phase induction motor. ***Learning Outcome:*** *A learner will be able to* *LO 2.4: Analyse performance of 3 phase induction motor for different speed control techniques. (P.I. 2.2.4) (P.I. 4.3.1)*	
	Theme for conducting Experiment: 8. Validate Open circuit and short circuit test results of 3 phase induction motor using modern engineering tool. ***Learning Outcome:*** *A learner will be able to* *LO 2.5: Demonstrate proficiency in identified modern engineering tool to validate O.C. and S.C. test results of 3 Phase I.M. (PI 5.1.1) (PI 5.2.2) (P.I.11.2.2)*	
03	**1-Phase Induction Motors:** ***Learning Objective:*** *To comprehend the performance characteristics of 1 phase induction motors by performing different tests.*	**04**
	Theme for conducting Experiment: 9. Analyze the effect of load on the performance of a single-phase induction motor. ***Learning Outcome:*** *A learner will be able to* *LO 3.1: Analyze effect of change in the load on different parameters of 1 phase AC Induction motors and represent results/ readings using norms of practice of effective team work. (P.I. 2.1.2) (P.I.4.3.1) (P.I.8.1.2) (P.I.11.3.1)*	
	Theme for conducting Experiment: 10. Determine the equivalent circuit parameters of single phase induction motor by conducting appropriate tests. ***Learning Outcome:*** *A learner will be able to* *LO 3.2: Use readings of O.C. and S.C. test of single phase induction motor to determine equivalent circuit parameters. (P.I. 2.1.2) (P.I.4.3.1)(P.I.8.1.2) (P.I.11.2.2)*	
04.	**Synchronous Machines:** ***Learning Objectives:*** *Study performance of Synchronous machines under different operating conditions and compare voltage regulation estimation using various methods.*	**08**

	Theme for conducting Experiment: 11. Analyze performance of Synchronous generator by performing direct load test. ***Learning Outcome:*** *A learner will be able to* *LO 4.1: Identify the effect of change of load and excitation on the performance of synchronous machine and present results as a team. (P.I.2.1.2) (P.I. 4.3.1) (P.I. 8.3.1) (P.I.11.2.2)*	
	Theme for conducting Experiment: 12. Determine and compare voltage regulation of alternator obtained by indirect methods. ***Learning Outcome:*** *A learner will be able to* *LO 4.2: Perform O.C. and S.C. test on synchronous generator and determine voltage regulation by different methods. Analyze results and find best method of voltage regulation underlying the limitations of each one. (P.I. 2.2.4) (P.I. 4.3.2) (P.I.11.3.1)*	
	Theme for conducting Experiment: 13. Demonstrate and verify different conditions of synchronization/ parallel operation of alternator. ***Learning Outcome:*** *A learner will be able to* *LO 4.3: Extract desired understanding and conclusions consistent with objectives and limitations of the parallel operation of alternator. (P.I. 2.2.2) (P.I.11.2.2)*	
	Theme for conducting Experiment: 14. Analyze the effect of variation of load as well as an excitation on three phase synchronous motor. ***Learning Outcome:*** *A learner will be able to* *LO 4.4: Identify variables and plot 'V' curve and inverted 'V' curve using standard norms of practice. (P.I.2.1.2) (P.I.8.1.2) (P.I.11.3.1)*	
	Theme for conducting Experiment: 15. Determine the direct axis and quadrature axis reactance of salient pole synchronous machine. ***Learning Outcome:*** *A learner will be able to* *LO 4.5: Determine value of X_d and X_q in synchronous machines using slip test. (P.I.2.1.2) (P.I.11.2.2)*	
	Minimum 03 experiments from each module, and total at least 10 experiments	

Performance Indicators:

P.I. No.	P.I. Statement
2.1.1	Articulate problem statements and identify objectives
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities.
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data.
4.3.2	Analyze data for trends and correlations, stating possible error and limitations
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
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.

Course Outcomes: Learner will be able to

1. Analyze the performance of 3φ transformer under various operating conditions..(LO 1.1) (LO 1.2) (LO 1.3)
2. Analyze performance characteristics of 3 phase induction motor using different tests. (LO 2.1) (LO 2.2) (LO 2.3) (LO 2.4) (LO 2.5)
3. Analyze effect of load on the performance characteristics of 1 phase induction motor and determine equivalent circuit parameters. (LO 3.1) (LO 3.2)
4. Validate voltage regulation and analyze other performance parameters of synchronous machines by conducting suitable tests. (LO 4.1) (LO 4.2) (LO 4.3) (LO 4.4) (LO 4.5)

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELC508.1		3		3				3			3
EELC508.2		3		3	3			3			3
EELC508.3		3		3				3			3
EELC508.4		3		3				3			3
Average		3		3	3			3			3

Text Books :

1. Bimbhra P.S., Electric Machinery , Khanna Publisher
2. Bimbhra P.S., Generalized Machine Theory, Khanna Publisher
3. D.P.Kothari, I.J. Nagrath, Electrical Machines, Tata McGraw Hill Education Private Limited

Reference Books :

1. M.G. Say, Performance and Design of Alternating Current Machines, CBS Pub.
2. Ashfaq Husain, Electric Machines, Dhanpat Rai and Co.
3. A.E. Fitzgerald, Kingsly, Stephen., Electric Machinery, Tata McGraw Hill

Other Resources :

1. NPTEL Course: Electrical Machines-II By Prof. Krishna Vasudevan, Prof. G. Sridhara Rao, Prof. P. Sasidhara Rao, IIT-Madras Weblink: https://nptel.ac.in/courses/108/106/108106072/
2. NPTEL Course: Electrical Machines By Prof. G. Bhuvaneshwari, Dept. of Electrical Engineering ,IIT-Delhi. Weblink:- https://nptel.ac.in/courses/108/102/10810214
3. NPTEL Course: Electrical Machines-II By Prof. Tapas Kumar Bhattacharya, Dept. of Electrical Engg. ,IITKharagpur. Weblink:- https://nptel.ac.in/courses/108/105/108105131/

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Lab experiments: 10 Marks
- Internal Assessment:10 Marks
  Evaluating proficiency in the field by assessing the candidate's capability to execute connection or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through analysis of the data during laboratory session.
- Regularity and active participation - 5 Marks

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

Students will be assessed based on three parameters:

- Drawing circuit diagram, Observation Table, Relevant formula (5Marks)
- Experiment conduction (5Marks)
- Sample calculations and conclusion(5Marks)
- Oral: 10 Marks.

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table and write relevant formula. It 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 performance of the experiment.

- Students will be allocated one hour to complete the circuit connections and take readings. The connections and output are then checked by both the examiners for its correctness. The weightage is 05 Marks
- Students will do sample calculations, draw graph if required and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 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
AEC	AEC 502	PROFESSIONAL COMMUNICATION & ETHICS-2	02

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

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Teamwork
3. PO9 : Communication
4. PO11: Life-long learning

Course Objectives:

1. To inculcate in students, professional and ethical attitude, effective communication skills, team work and a multidisciplinary approach.
2. To provide students with an academic environment where they will be aware of the need for excellence, leadership and lifelong learning to build a successful academic & professional career.
3. To create awareness about professional ethics and codes of professional practices.
4. To prepare students for a successful academic and/or professional career that meets the global academic and/or corporate requirement by providing students to work on multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork, and other interpersonal skills.

Module	Details	Hrs.
	Course Introduction The curriculum of Professional Communication and Ethics-2 is designed to provide students with an academic environment that promotes a professional and ethical attitude as they participate in individual and team activities. The practical sessions will supplement the learner's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global industrial and corporate requirements. The curriculum will create an awareness of professional ethics and the standard code of conduct. It will further inculcate within the budding engineer the social commitment as responsible technical citizens. It will enhance the learner's team building capacities, interpersonal skills and leadership skills so as to become a well-rounded professional in their field of expertise.	**01**

01.	**Employability Skills** ***Learning Objectives:*** *1. Customised writing skills and Content Development: To develop effective writing skills to craft a clear, concise, and compelling Statement of purpose, formal letters and resumes for a specific purpose.* *2. To instil productive and efficient skills to participate confidently and constructively in group discussions and interviews for employability* *3. To inculcate Ethical Communication & Empathetic Listening*	
	Contents: **1.1 Business Correspondence** o Letter Writing (Principles, Format, Structure, Content, Types) o Job Application Letter o Joining Letter o Resignation Letter o Resume Writing **1.2 Statement of Purpose/ Letter of Intent or Interest** o Purpose o Elements of SOP/LOI o Structure o Tips for writing effective and ethical SOP/LOI **1.3 Verbal Aptitude Tests** modeled on CAT,GRE,GMAT,IELTS **1.4 Group Discussions**: Purpose, parameters of evaluating, Types of GDs (Traditional, Case-based & Role Plays), GD Etiquettes, and Importance of inclusivity, respectful listening and expression of diverse ideas for a common goal. **1.5 Personal Interviews:** Preparation, Types of questions, Types of interviews and modes of interviews. Types: Structured, Stress, Behavioural, Problem Solving & Case-based, Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual **1.6 Significance of Ethical approach during Group Discussions and Interviews** o Respectful listening o Speaking Assertively o Inclusivity of diverse individuals o Mindfulness and openness to different ideas o Common Goal of Consensus	**03**
	Self-Learning Topics: ***Watch recordings of professional interviews from online resources.(ex: Civil Service interviews), IIM and UPSC GDs*** ***Activities:***	

	1. Prepare an SOP for admission procedure in a reputed university. *2. Participate in GDs on a given topic followed by Mock Interview.* *3. Attempt Verbal Aptitude and Comprehension Tests.* *4. Write a Job Application/Resignation/Request/Enquiry letter in the learned format* *5. Write a Resume as a fresh graduate trainee for a specific post.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Write clear, concise and professional letters of various types that effectively convey information, build relationships and achieve professional objectives.(9.1.3, 9.2.3, 9.3.2, 11.1.1)* *LO 1.2: Rationally apply gained knowledge of group discussions and aptitude tests for continuous improvement and professional growth in academia and industry. (8.1.2, 8.2.1, 11.1.1.)* *LO 1.3: Exhibit the ethical code of conduct by treating all team mates with respect and dignity, by listening attentively to each member, and encouraging diversity of ideas during a GD. (7.3.1, 8.1.1, 8.2.2,8.2.3, 8.2.4, 9.2.3)* *LO 1.4: Demonstrate through group discussions and mock interviews, the ability to effectively identify unethical conduct and arrive at ethical decisions through strong leadership skills and respectfully lead a team or oneself to the desired goal. (7.1.1,8.1.2,8.2.1,8.2.3, 8.2.4, 8.3.1,9.2.2, 9.2.3)* *LO 1.5: Exhibit a calm demeanor by effectively preparing for competitive exams through mock tests which contain comprehending logical instructions, analysis, problem solving and verbal aptitude assessment (8.2.4, 9.1.1,11.1.1)*	
02.	**Interpersonal Skills & Ethics** ***Learning Objectives:*** 1. *Develop Problem Solving & Critical Thinking: To help budding engineers understand the importance of interpersonal skills and demonstrate creativity, resourcefulness, along with enhanced communication in personal and professional settings.* 2. *Self-Management & Ethical Awareness: To create awareness of Ethical and Social Responsibility towards individual and society by fostering self and team management leading to increased productivity and job readiness.*	**03**
	Contents: **2.1 Interpersonal Skills (implementation in all AE activities)** o Emotional intelligence o Effective Leadership o Team Building o Conflict Management o Negotiation & Ethical Conflict Resolution o Time management, o Assertiveness **2.2 Importance of Ethics in Interpersonal Relations** o Ethical and Inclusive Decision making. o Ethics in relation to Emotional Quotient	

	Self-Learning Topics: Follow industry leaders and experts on social media or read articles on topics related to corporate ethics and social responsibility. ***Activity:*** 1. *Listen to podcasts that discuss ethics, communication and interpersonal skills, such as "The TED Radio Hour" or "How I Built This" and conduct a GD on its learnings.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the learned interpersonal skills in various A.E. activities such as Report presentations, drafting business plans and SOP in an accepting, respectful and inclusive manner. (7.3.1,8.1.1, 8.1.2, 8.2.1, 8.2.2, 9.2.1, 9.2.3)* *LO 2.2: Apply the awareness of ethics while participating in a well-organized, time bound and constructive GD on topics raising ethical and moral concerns. (7.2.2, 7.3.1,8.2.1, 8.3.1, 9.2.3)* *LO 2.3: Apply empathetic and effective speaking skills utilizing ethical values and principles to resolve any social problem while working in a diverse team for group activities. (7.2.2, 7.3.18.1.1, 8.2.1, 8.2.2, 8.2.3, 9.2.1, 9.2.2.)* .	
03.	**Advanced Technical Writing: project/problem based learning** ***Learning Objective:*** *1. Structure & Organisation: To enable the learner to craft a well-structured technical report, utilizing a logical flow with clear introduction, body and flow, ensuring clarity and coherence in their writing.* *2. Effective Communication: To enhance the ability to communicate complex information clearly and concisely, using relevant visual aids and making the information accessible to technical and non-technical audience.*	**03**
	Contents: **3.1 Technical/Academic Report** o **Classification of reports on the basis of**: Subject Matter, Time Interval, Function, Physical Factors. o **Parts of a long formal report**: Front Matter, Main Body and Back Matter. o **Language and style of Reports:** Grammar, Tone, Style, Vocabulary, Format of the report from title page to appendices. **3.2 Definition, purpose and types of Proposal** o Parts of a Proposal**:** Elements, Scope and Limitations, Conclusion o Technical Proposal/Synopsis **3.3 Technical Paper Formats (APA/IEEE)** **Parts of a Research paper**: o Title Page o Abstract, o Introduction o Problem Statement/Hypothesis o Research methods, o Data Search (Primary/Secondary) o Quantitative/ Qualitative Analysis o Discussion,	

	○ Delimitations, ○ future scope and ○ References. ○ Appendix ○ Acknowledgement **3.4 Significance of Presenting and Publishing a Research Paper** ○ Reading Secondary Data ○ Looking for research gaps ○ Understanding Need to fill research gap ○ Creating a Problem Statement ○ Writing a Synopsis ○ Writing an academic paper in the APA/IEEE format	
	Self-Learning Topics: ***Read academic research papers and look for gaps in the research area.*** ***Activity*:** *1. Prepare an Academic Research Paper on any technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *The learner will be able to* *LO3.1: Write, individually or as a team, a research paper, with logical & rational progression of ideas, effectively, in a time bound manner to everyone's understanding (8.3.1, 9.1.3, 9.2.3)* *LO3.2: Read, comprehend, and interpret previous research/ secondary source data and clearly state the purpose of research using the IEEE format. (9.1.1,9.1.3,11.3.1)* *LO3.3: Demonstrate the ability to use critical thinking to find gaps in research, interpret the technical and non-technical data and present it with clarity. (9.1.1, 9.1.3, 11.1.2, 11.3.1)* *LO3.4: Apply gained knowledge of technical writing for continuous improvement in academia and professional growth. (11.1.1)*	
04.	**Technical/Business Presentations** ***Learning Objectives:*** *1. The development of effective presentation structure and content for academic and technical presentation with the help of ICT* *2.Capacity building for delivering confident and persuasive presentation to both technical and non-technical audience individually or in a team.*	**02**
	Contents: **4.1 Effective Presentation Strategies:** ○ Purpose of a presentation, ○ Understanding the audience, location and the event, ○ Arranging the material, structuring the presentation, ○ Making effective slides and platform skills. **4.2 Group Presentations:** ○ Working with a mixed team (Diversity) ○ Sharing responsibility in a team (Delegation) ○ Creating the content together (Uniformity)	

	○ Transition phases and Coordination. (Teamwork) ○ Time Management (Individual and Team) **4.3 Individual Presentations:** ○ Introduction of Self and Topic ○ Understanding the audience, building rapport ○ Time Management ○ End with Q n A, Feedback	
	Self-Learning Topics: *Watch YouTube videos of presentations like TED TALKS on motivational topics* ***Activity*:** *1. Prepare an academic research paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Demonstrate efficacious and seamless presentation skills to all audiences as an individual and a team with impeccable leadership qualities through proper delegation, problem solving and management (8.1.2, 8.2.1,8.3.1, 9.1.3, 9.2.2, 9.3.2)* *LO4.2: Engage with a diverse team and a mixed audience, during presentations, keeping in mind their uniqueness and differences. (7.3.1.,8.1.1,8.1.2,8.3.1,9.2.2, 9.2.3)*	
05.	**Corporate Ethics** ***Learning Objective/s:*** 1. *Ethical Principles & Frameworks: To aid the learner to differentiate between various codes of conduct and ethics in the social and professional world.* 2. *Analyse & Resolve Ethical Dilemmas: To enforce the significance of ethical citizenry & generate awareness on the importance of IPR and its consequences*	**02**
	Contents: **5.1. Intellectual Property Rights : Significance, Duration, Laws** ○ Copyrights ○ Trademarks ○ Patents ○ Geographical Indication ○ Industrial Designs ○ Trade Secrets **5.2. Start- Up Skills:** ○ Financial Literacy ○ Risk Assessment ○ Data Analysis. **5.3. Gender Equity & Inclusivity at the Work Place** ○ Study on Cases related to Gender Equity in India & Global ○ Corporate Social Responsibility ○ Inclusivity at the work place ○ Corporate Code of Conduct	

	Self-Learning Topics: Read a biography on a Business Leader/Philanthropist, Collect information on some failed startups. Assess and analyse the reasons for their failure. ***Activity:*** 1. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* 2. *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Utilise professional, moral and ethical principles to identify wrong conduct and suggest ethical solutions through IPR, Gender Equity and Corporate ethics (7.1.1, 7.2.2, 7.3.1)* *LO 5.2: Critically evaluate various socioeconomic, gender issues of discriminatory nature, while emulating equality and open mindedness in all teams, sectors and activities. (7.1.1, 7.2.2,7.3.1, 8.1.1, 8.1.2, 9.2.3)* *LO 5.3: Employ the awareness of IPR to avoid or solve unethical practices in professional life by following standard rules and practices and emerge as a productive team member and a progressive leader. (7.1.1,7.2.2, 8.2.1, 8.2.2, 11.1.1)* *LO 5.4: Assess a failed business plan, analyse reasons for failure and suggest viable solutions as a team keeping in consideration both the individual and team effort. (8.2.1, 8.3.1,9.1.3, 11.1.2)*	
	Activities for Ability Enhancement (Practical Sessions):	**30**
	Contents: 1. *Write a job application letter, a joining letter, a letter of apology, a request letter. Attach a Resume to the Job Application letter. Follow Standard formats and protocols for each document. (5M)* 2. *Prepare an Academic Research Paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper (5M) + Presentation & Group Dynamics (5M)]* 3. *Prepare an SOP for admission procedure in a reputed university. (5M)* 4. *Participate in GDs on given topic followed by Mock Interview ((10 M)* 5. *Attempt Verbal Aptitude and Comprehension Tests(5M)* 6. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* ***OR*** *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)* 7. *Active Participation & Regularity (5M)*	
	Activities will start in the inverted pyramid, viz., with group activities first so as to build confidence and ending with solo presentations in the form of research paper presentation or Gender Equity presentation. *Group Discussion, Interview Skills, Presentation skills will have at least three mock drills before the final assessment of the same.* *Rigorous development of the English language, social and professional etiquette will be the praxis*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies
7.3.1	Apply and exhibit universal human values and a diverse and inclusive mind-set, free of discrimination
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.2.2	Treat other team members respectfully
8.2.3	Listen to other members
8.2.4	Maintain composure in difficult situations
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.2.3	Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team.
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	State the rationale for the requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Communicate and present effectively and ethically with mixed media in both oral and written forms business reports and documents which will in turn provide a solid foundation for their future managerial roles. (*LOs 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1)*
2. Exhibit the skill set required for successful employability while expressing ethical, assertive and inclusive leadership skills. (*LOs 2.1, 2.2, 2.3, 3.2, 4.2, 4.3, 5.2)*
3. Develop a critical thinking acumen to prepare for and give various competitive exams, emerge successful in group discussions and conduct healthy debates. (*LOs 1.3*, *2.1, 2.2, 2.3, 3.1, 4.2)*
4. Develop creative and mindful thinking while demonstrating the knowledge of professional and personal etiquettes & ethics, such as diversity and inclusivity, in the global environment. (*LOs 1.2, 2.2, 2.4,1.3, 3.2, 4.3, 5.1, 5.2, 5.3, 5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
AEC502.1							3	3	3		3
AEC502.2							3	3	3		3
AEC502.3							2	3	3		3
AEC502.4							3	3	3		3
Average							3	3	3		3

Reference Books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin:*
2. *Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill. 2. Bovée, C. L., &Thill, J. V. (2021).
3. *Business communication today*. Upper Saddle River, NJ: Pearson.
4. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
5. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South Western Cengage Learning.
6. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
7. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
8. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
9. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Other Resources :

1. NPTEL Course: https://archive.nptel.ac.in/courses/109/104/109104030
   Dept. of Humanities and Social Sciences, IIT Kanpur, A Course on Communication Skills

CONTINUOUS INTERNAL ASSESSMENT (50 Marks)

1. Assignments on Resume Writing and Business Correspondence (5M)
2. Prepare an Academic Research Paper (3500-4000 words) on any one socio-technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper/ IEEE (5 M) + Presentation & Group Dynamics. (5M)]

3. Prepare an SOP for admission procedure in a reputed university. (5M)
4. Participation in Final GD on concrete/abstract topic followed by Mock Interview. (10M)
5. Verbal Aptitude Tests (5M)
6. Analyse a Case Study on the topic of Gender Equity & Inclusivity and present (APA) OR Analyse a failed start up present your case to a mixed audience (APA) (10M)
7. Regularity and Active participation (5M)

Course Type	Course Code	Course Name	Credits
MNP	EEMNP503	MINI PROJECT- 2A	01

Program Outcomes addressed:

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

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

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

Guidelines for the Mini Project

Mini project may be carried out in one or more form of following:

Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

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

- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

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

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

Semester V:

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

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

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

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

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
HSS	HSS502	ENTREPRENEURSHIP	02

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

Pre-requisite: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer & The World.
5. PO7: Ethics
6. PO10: Project Management & Finance
7. PO11: Life-long learning

Course Objectives:

1. To develop Entrepreneurial mindset amongst the learners.
2. To promote Entrepreneurship as life-skills to improve quality of life, skills of creation and management of entrepreneurial pursuits.
3. To explore paths of the innovation through the creative problem-solving skills
4. To familiarize with the steps involved in 'idea to product' development.
5. To get acquainted with the preparation of pitch at ideation, business idea presentation and funding stages

Module	Details	Hrs
00	**Course Introduction:** This course aims to equip individuals with the knowledge, skills, and mindset needed to identify and pursue new business opportunities. It aims to foster an entrepreneurial culture and mindset to help develop the next generation of entrepreneurs who can create jobs, drive economic growth, and contribute to the society. Entrepreneurship is a life skill that will help an individual succeed in a variety of scenarios, both personal and professional. By its very nature, entrepreneurship is an interdisciplinary field that draws from a range of disciplines, including business, economics, engineering, and social sciences. Some of the key topics covered in Entrepreneurship Course include opportunity recognition, market research, business planning, financing, marketing, and management while emphasizing the development of critical thinking, creativity, risk-taking, and problem- solving skills.	1

1	**Fundamentals of Entrepreneurship**	5-6
	***Learning Objectives**:* • *To gain knowledge about the concepts and principles of entrepreneurship, including opportunity recognition and value creation.* • *To develop an entrepreneurial mindset and skills that will enable them to identify, evaluate, and pursue viable business opportunities with confidence.*	
	Contents: Introduction to Entrepreneurship, Entrepreneurial Mindset, Opportunity Identification, Market Analysis & Customer Research, Business Models & Go-to-Market, Funding and Financial Management, Marketing Aspects, Scaling the Venture and Growth Strategies: *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Understand the concept of Entrepreneurship* • *State the myths, advantages and limitations of Entrepreneurship* • *Interpret and analyze market research data and customer analysis to make informed business decisions.* • *Discuss the steps in the process of Entrepreneurship*	
2	**Technological Innovation and Entrepreneurship**	4-5
	Learning Objectives: • *To enhance creative problem-solving skills and to examine the importance of innovation in business success.* • *To identify the types of Innovation* • *To gain knowledge for taking an idea to product development stage while protecting the idea with IPR.*	
	Content: Foundations of Creativity and Innovations, Creative thinking process, Types of Innovation: Incremental, Disruptive, and Radical, Innovation Process: from idea to execution; Protecting ideas - Patents and IPR. Exploring Technological Innovation through Case Studies.	
	Learning Outcome: *The learner would be able to* • *Use their understanding of the role Technological innovation plays in driving business success.* • *To formulate steps for taking an idea to product stage with necessary patents*	
3	**Ideation, Prototyping, Testing, Validation and Commercialisation**	5-6
	Learning Objectives: • *Experiment to test Minimum Viable Products (MVPs) and validate business ideas.* • *To formulate a Build-Measure-Learn feedback loop for continuous improvement.*	

	Contents: Identifying customer needs and problems to solve, Ideation, Concept Development, Design Thinking, Prototyping, Minimum Viable Product (MVP), Testing, and Iterations. Understanding the Market, customer feedback and refinement of business idea based on feedback. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Select specific measures to design, test, and validate Minimum Viable Products (MVPs) to assess business ideas.* • *Interpret the learnings from the build-measure-learn feedback loop to facilitate continuous improvement and learning.*	
4	**Financial Resources**	3-4
	Learning Objectives: • *Describe the key concepts, and strategies related to fundraising for entrepreneurial ventures.* • *Compare various funding sources, including angel investors, venture capitalists, grants, and crowdfunding platforms.* • *Devise and create compelling investor pitches, develop financial projections.*	
	Contents: Funding new ventures – bootstrapping, crowd sourcing, Angel investors, VCs, debt financing, and due diligence; Raising fund during life-cycle of a new ventures. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Recognize various fundraising strategies and techniques, enabling s to choose the most appropriate funding sources for their entrepreneurial ventures.* • *Sketch effective pitches and fundraising campaigns tailored to different types of investors and funding sources, ensuring successful capital-raising efforts.*	
5	**National Entrepreneurial Culture**	4-5
	Learning Objectives: • *To gain knowledge of legal and regulatory requirements for startups, including compliance with relevant regulations.* • *To identify the various government initiatives to develop the start-up ecosystem.*	
	Contents: Entrepreneurial Ecosystem in India, Key regulations and legal aspects, Forms of Business Ownership, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments,	

	banks etc. Government incentives for entrepreneurship, Incubation, & Acceleration.	
	Learning Outcome: *The learner would be able to* • *Describe the current scenario of Entrepreneurial activity in India.* • *To state legal and regulatory requirements and compliances for start-ups.* • *To state the various government initiatives to support the entrepreneurs.*	
6	**Start-up Case Studies**	3-4
	***Learning Objectives**:* *To relate the real life case studies and analyse them for acquiring the clarity on various aspects of entrepreneurship covered in the first 5 modules*	
	Contents: Case Studies of various start-ups (with Indian Context): Start-ups from Tech, Edtech, Fintech, and Agriculture domain; Study of successful start-ups and failed start-ups.	
	Learning Outcome: • *To evaluate the real-world examples and case studies that will help them understand the practical aspects of idea to product, fundraising and financial management in the context of entrepreneurship.*	
	Course Conclusion	1
	Total	30

In-semester Assessment - Continuous Assessment: Suggested

1 Teams of 3-4 students shall present a One-Minute business idea pitch– ideation phase-10 marks
2 Teams of 3-4 students shall present a Three-Minute Business Pitch –Validation phase-10 marks
3 Teams of 3-4 students shall present a Five-Minute Business Pitch for Funding- 15 marks
4 Teams of 3-4 students shall present analysis of one case study of successful or failed start-up- (15 Marks)

Course Outcome: Learner will be able to

CO1: State the concept of Entrepreneurship and Indian Start-up ecosystem
CO2: Identify the business ideas and to analyse the environment for potential business opportunity.
CO3: Identify the specific measures to design, test, and validate Minimum Viable Product.
CO4: State the key concepts, and strategies related to fundraising for entrepreneurial ventures.
CO4: Identify the legal and regulatory framework for entrepreneurs in Indian context.
CO5: Analyse and correlate the reasons for the success or the failure of entrepreneurial firms.

Text Books:

1. Poornima Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House

5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
7. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.

Reference Books:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
3. India as Global Start-up Hub: Mission with Passion by C B Rao
4. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker
5. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich, Veland Ramadani, Springer (2017)
6. Entrepreneurship- Theory, Process Practice –by Kuratko &Hodgetts, Thompson South-Western Publication

Relevant Websites:

1. www.msme.gov.in
2. www.dcmesme.gov.in
3. www.msmetraining.gov.in

Other Resources:

1. NPTEL Course: Entrepreneurship By Prof. C Bhaktavatsala Rao, IIT Madrao
   Weblink https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. NPTEL Course: Entrepreneurship Essentials By Prof. Manoj Kumar Mondal, IIT Kharagpur
   Weblink https://onlinecourses.nptel.ac.in/noc21_ge06/preview

Course Type	Course Code	Course Name	Credits
PCC	EEPCC611	DRIVES AND CONTROL	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. EEPCC406: Control System
2. EEPCC407: Power Electronics
3. EEPCC509: Electrical Machines

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO9: Communication
5. PO11: Lifelong learning

Course Objectives: To impart knowledge on

1. Fundamental features and dynamics of electrical drives.
2. Selection of motor power rating for applications designed for different duty cycles.
3. DC and AC drives with control schemes.
4. Practical applications of electrical drives.

Module	Details	Hrs
	Course Introduction Electrical drives are extensively utilized in industries and everyday applications for motion control. It is important for electrical engineers to learn drives and control systems, as they are key to operating and managing electrical machines**.** Large scale deployment of electric vehicles has further highlighted the significance of drives and control. To effectively master electrical drives, it is essential to understand their components and dynamics, as this knowledge influences drive selection and performance optimization.	**01**
01.	**Electrical Drives - Introduction & Dynamics:**	**04-05**
	Learning Objective/s: *Acquire the ability to apply the knowledge of motor load system dynamics to analyze the operation of the drive and comprehend the components of electrical drives in real-life examples.*	
	Contents Introduction, Parts of Electrical Drives with a case study, Choice of Electrical Drives, Fundamental Torque equations, Speed-Torque conventions and Multi-quadrant Operation, Equivalent values of Drive Parameters, Measurement of Moment of Inertia, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability.	
	Self-Learning Topics: *Load equalisation.*	
	Learning Outcomes: *A learner will be able to*	

	LO1.1: Apply the fundamental torque equation (based on Newton's law) to find the transient response of electrical drives (PI 1.3.1). *LO1.2: Apply the relevant equations of electrical machines to solve problems related to electrical drives (PI 1.4.1).* *LO1.3: Interpret the factors affecting the choice of electrical drives for various applications (PI 2.1.3).* *LO1.4: Analyze the steady state stability of a drive in all the four quadrants (PI 2.2.4).*	
02.	**Selection of Motor Power Rating**	**06-07**
	Learning Objective: *To acquire a skill to choose the appropriate motor power rating for applications of different duty cycles.*	
	Contents: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating: Continuous duty; Equivalent current, Torque and Power Methods for Fluctuating and Intermittent Loads; Short Time Duty; Intermittent Duty.	
	Self-Learning Topics: *Identify the availability and specifications of different duty cycle motors from the catalogue available in the motor manufacturer's website.*	
	Learning Outcomes: *A learner will be able to* *LO2.1: Derive the thermal model equations and draw the heating and cooling curves of the motor (PI 2.3.1)* *LO2.2: Derive the equivalent current, Torque and Power equations for Fluctuating and Intermittent Loads (PI 1.4.1)* *LO2.3: Refer the manufacturer's website to identify the different classes of motor duty and explain their relevance with suitable example applications. (PI 1.3.1, 11.3.1).* *LO2.4: Select the motor power rating of a motor for applications intended for various duty cycles considering the overload factor and constraints like maximum allowable current and breakdown torque (PI 2.2.3).*	
03.	**Basic Control Aspects of Four Quadrant DC Drives**	**05-06**
	Learning Objective: *To gain knowledge on the fundamental control aspects of electrical drives, particularly focusing on four quadrant DC drives*	
	Contents: Review of Basic multi-quadrant speed torque characteristics and equations of DC motors, DC separately excited motor: Modes of Operation, Speed Transitions during Acceleration and Deceleration showing the quadrant of operation, Single and Three Phase Fully Controlled Converter based Separately Excited DC Motor Drive. Chopper based multi-quadrant Separately Excited DC Motor Drive, Closed loop control – Torque control, Speed control loop with inner current control loop. (No Numerical on this Module)	
	Learning Outcomes: *A learner will be able to* *LO3.1: Identify the different modes of operation of electrical drives and draw the speed torque characteristics of both motor and load. (PI 1.3.1)* *LO3.2: Analyze different closed loop control schemes of drives – Torque control, Speed control loop with inner current control loop (PI 1.4.1)* *LO3.3: Apply the basic multi-quadrant speed torque characteristics and equations of DC motors to analyze the operation of power electronic DC drives. (PI 2.1.3)* *LO3.4: Analyze the multi-quadrant operation of fully controlled converter fed and chopper fed separately excited dc motor. (PI 2.2.3)*	
04.	**Induction Motor Drives**	**09-10**
	Learning Objective: *To gain knowledge on the basic control schemes in induction motor drives*	

	Contents: Basic Multi-Quadrant Speed-Torque Characteristics and Equations of Induction Motor (IM), Regenerative Braking, Plugging, Speed Transitions during Acceleration and Deceleration, Speed Control: Stator Voltage Control, Variable frequency Drive (VFD): V/f Control (Constant torque, constant power and constant slip region). Open loop V/f control, Soft starting with V/f control. Closed loop V/f control with slip regulation, Closed loop V/f control with torque and flux control.	
	Self-Learning Topics: Application reports for the implementation of V/f speed control of induction motor, provided by Texas Instruments, Infineon Technologies etc.	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply the basic multi-quadrant speed torque characteristics and equations of induction motors to solve problems on electrical drives. (PI 1.3.1)* *LO4.2: Analyze the transition in different modes of operation of IM with reference to regenerating braking and plugging. (PI 2.2.3)* *LO4.3: Analyze VFD in constant torque and constant power mode. Also show the speed transitions during acceleration and deceleration. (PI 2.2.2)* *LO4.4: Apply electrical engineering concepts and justify why it is suggested to have soft control rather than drastic variations of V and f. (PI 1.4.1)*	
05.	**Direct Vector Control of Induction Motor**	**08-09**
	Learning Objective: *To gain knowledge on direct vector control of IM and practical implementation of IM drives*	
	Contents: Review of d-q Model of Induction Motor, d-q Model of Induction Motor in synchronously rotating reference frame, Principle of Vector Control (also called as Field Oriented Control (FOC)), DC Motor Analogy, Voltage model of IM for flux estimation. Direct Vector Control Scheme, Comparison of Scalar and Vector control. Factors to be considered for the practical implementation of V/f control/Vector control of Induction Motor.	
	Self-Learning Topics: *Indirect Vector Control of IM: Application reports for the implementation of indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.*	
	Learning Outcomes: *A learner will be able to* *LO5.1: Analyze the d-q model of IM in synchronously rotating reference frame and interpret how direct and quadrature axis current can be made analogous to field and armature current of DC motor for direct vector control implementation (PI 2.1.3)* *LO5.2: Compare scalar and vector control of IM and decide the suitability of these control methods in various applications. (PI 2.2.4)* *LO5.3: Examine the relevant methods, tools and techniques for the practical implementation of V/f control/Vector control of Induction Motor (PI 4.1.2).* *LO5.4: Specify appropriate equipment and procedures for the practical implementation of V/f control/Vector control of Induction Motor (PI 4.2.1).*	
06.	**PMSM Drive for EV Application**	**05-06**
	Learning Objective/s: *Comprehend the suitability of PMSM drive for EV application.*	
	Contents: PM Synchronous Motor Control: permanent-magnet ac synchronous motor-surface-permanent-magnet (SPM) motors and interior-permanent-magnet (IPM) motors, Suitability of PMSM for EV application. Field-Oriented Control of PMSM, Flux-Weakening Control of PMSM.	

	Self-Learning Topics: *Watch videos on PMSM Drive for EV Application and other real-world electrical drives.*	
	Learning Outcomes: *A learner will be able to* *LO6.1: Identify the control of IM in constant torque region and constant power region and discuss the requirement of it in EV application. (PI-2.2.2)* *LO6.2: Identify the suitability of PMSM drive for EV application compared to that of IM drive referring credible sources of information. (PI-2.2.4, 11.3.1)* *LO6.3: Study anyone real-world electrical drive, find the main parts, understand how they work, and make power point slides to show the findings (PI 1.3.1, 9.1.3).* *LO6.4: Identify feasible improvements to enhance the performance of anyone real-world electrical drive (PI 2.2.4, 11.1.2).* *LO6.5: Deliver a clear and effective presentation on electrical drive systems, showcasing an understanding of essential components and drive performance through real-world examples (PI 1.4.1, 9.2.2).*	
	Course Conclusion The course on drives and control teaches how to apply the basics of electric motors, power electronics, and control systems in drives applications. Students learn to apply the knowledge of dynamics of motor load system to solve problems on electrical drives. Students learn how to analyse and use these systems in industry. Through hands-on labs and real-world examples, they gain practical skills to improve the performance of electric.	**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.
2.1.3	Identify the mathematical, engineering, and other relevant knowledge that applies to a given problem
2.2.2	Identify, assemble, and evaluate information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3.1	Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy
4.1.2	Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes:

Learner will be able to

1. Apply the basic principles of dynamics of motor load system to analyse the operation of electrical drives *(LO1.1, LO1.2, LO1.3, LO1.4).*
2. Choose the appropriate motor power rating for applications designed to operate under different duty cycles *(LO2.1, LO2.2, LO2.3, LO2.4).*
3. Analyse the primary control schemes of multi-quadrant DC drives *(LO3.1, LO3.2, LO3.3, LO3.4).*
4. Determine the suitability of scalar and vector control methods for induction motors in different applications and interpret the practical implementation aspects of any one method. *(LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4).*
5. Analyze real-life examples of electrical drives, outline their key components with functions, and present the findings during the class session *(LO6.1, LO6.2, LO6.3, LO6.4, LO6.5).*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPCC611.1	3	3									
EEPCC611.2		3									2
EEPCC611.3	3	3									
EEPCC611.4	3	3		3							
EEPCC611.5	3	3							3		3
Average	3	3		3					3		3

Text Books:

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. A First Course on Electrical Drives by S. K. Pillai, New Age International.
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR

Reference Books:

1. Electric Motor Drives: Modelling, Analysis and Control by Krishnan R, PHI
2. Power electronics by Muhammad H. Rashid, Pearson

Other Resources:

1. NPTEL Course: Fundamentals of Electric Drives, IIT Kanpur by Prof. Shyama Prasad Das https://nptel.ac.in/courses/108/104/108104140/
2. NPTEL Course: Industrial Drives - Power Electronics, IISc Bangalore by Prof. K. Gopakumar. https://nptel.ac.in/courses/108/108/108108077/
3. NPTEL Course: Industrial Drives, IIT Delhi by Dr.K .R. Rajagopal https://nptel.ac.in/courses/108/102/108102046/
4. Application reports for the implementation of V/f control and indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Numerical Assignment/s (minimum 20 problems) + Class test based on above numerical assignment: 10 Marks
   - Gather real-life drives information through reading articles, observations, watching videos, and present it in the class: 05 marks

- Regularity and Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
PE	EEPEC6021	LIGHTING SYSTEM 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 -Basic Electrical Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO6: The Engineer and The World
5. PO11: Life-long learning

Course Objectives:

1. To impart knowledge on various laws of illumination, lighting parameters, light sources, luminaries and their characteristics to be used for lighting design.
2. To impart knowledge on lighting design considerations for interior and exterior applications.
3. To impart knowledge on LED based solid-state lighting with different lighting control technologies and standards.

Module	Details	Hrs
	Course Introduction Lighting System Design course is a specialized course focusing on the design and implementation of lighting systems. Understanding the intricacies of light and how it interacts with spaces is crucial for creating efficient and aesthetically pleasing lighting designs. This course enhances knowledge and helps discover the latest trends and techniques in the field. Hence, the fundamental concepts of this course are essential for designing the lighting systems.	01
01.	**Introduction:**	04-05
	Learning Objective/s: *To study various lighting parameters and apply the laws of illumination for the Photometric measurements.*	
	Contents Review of Light, Color and Photometry: Laws of illumination, illumination entities. Radiometric and photometric standards, Photometers, Photometric measurement procedure for assessment of lamp efficacy, Color temperature, CRI, Glare, lighting level, uniformity, contrast, modeling effect, directional lighting, diffused lighting	
	Self-Learning Topics: *Structure of Eye, Adaptation, Accommodation*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply laws of natural science to perform the photometric measurements (PI-1.2.1)*	

	LO 1.2: Apply basic principles to solve problems based on laws of illumination (PI-1.4.1) *LO 1.3: Identify lighting parameters and analyze their characteristics for designing lighting systems(PI-2.1.2)* *LO 1.4:Identify existing processes/solution methods for analyzing the photometric measurements (PI-2.2.3)*	
02.	**Sources of Light**	**06-07**
	Learning Objective: *To teach various lamps, lighting components/ subsystems, thermal management and lifetime studies.*	
	Contents: Sources of Light, Review of development, construction and characteristics of Lamps: Incandescent lamp, Halogen lamp, Discharge lamps: Fluorescent lamp, High-pressure discharge lamps, Metal Halide lamp, Induction lamp, and LED lamp. OLEDs, light-emitting polymers (LEPs), Thermal Management and Lifetime Studies.	
	Self-Learning Topics: *Low Pressure and High Pressure Sodium Vapour lamp, High pressure Mercury Vapour lamp*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply laws of natural science to study the characteristics of lamps(PI-1.2.1)* *LO 2.2: Apply fundamental engineering concepts to solve lighting system design problems (PI-1.4.1)* *LO 2.3: Identify lighting components and analyze the characteristics of various lamps (PI-2.1.2)* *LO 2.4: Identify existing processes/solution methods for analyzing the performance of various lamps (PI-2.2.3)*	
03.	**Luminaries**	**05-06**
	Learning Objective: *To impart knowledge on various control gear, lighting fixtures and lighting schemes for various lamps.*	
	Contents: Optical control, Control gear: ballast, standard and electronic, Luminaries photometry, Drivers for LED lamps, standards and regulations, LED luminaries, LED Light Distributions, Lighting fixtures, High bay, Low bay luminaires, Direct/ indirect light luminaires	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify and analyse control gear for various light sources (PI-2.1.2)* *LO 3.2: Identify existing processes/solution methods for control gear (PI-2.2.3)* *LO 3.3: Extract engineering requirements from relevant engineering codes and standards of lighting system design for protection of the public (PI-3.1.4, 6.2.1)* *LO 3.4: Determine objectives, functional requirements and arrive at specifications and apply principles for sustainable development using LED luminaires (PI-3.1.6, 6.3.4)*	
04.	**Interior Lighting Design and Calculation**	**09-10**

	Learning Objective: *To teach the concepts of design for an Interior Lighting system through standards, design considerations and calculation for different application areas and simulate using modern tools.*	
	Contents: Objectives, quality and quantity of lighting. Lamp /Luminaire selection and placement, design considerations and calculation. Glare Consideration and control. Indoor lighting design by lumen method, point-by-point method. Applications: residential, educational institute, industries, sports centers, commercial premises: retail stores, offices etc. Applicable standards.	
	Self-Learning Topics: *Simulate interior lighting design using software tools and analyse results.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply fundamental engineering concepts in interior lighting design using lumen method (PI-1.3.1)* *LO 4.2: Apply basic principles to solve interior lighting design problems using lumen method (PI-1.4.1)* *LO 4.3: Extract engineering requirements from relevant engineering Codes and Standards for interior lighting design applications (PI-3.1.4, PI-6.2.1)* *LO 4.4: Determine design objectives, functional requirements and arrive at specifications for interior lighting design applications for sustainable development (PI-3.1.6, 6.3.4)*	
05.	**Exterior Lighting Design and Calculation**	**07-08**
	Learning Objective: *To teach the concepts of design for an Exterior Lighting system through standards, design considerations and calculation for different application areas and simulate using modern tools.*	
	Contents: Exterior lighting system- Road lighting system, lighting at junctions, Utility area lighting, Sports lighting, Tunnel lighting, Decorative flood lighting, Building Façade lighting. Applicable standards	
	Self-Learning Topics: *Simulate Exterior lighting design using software tools and analyse results.*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply fundamental engineering concepts in exterior lighting design using lumen method (PI-1.3.1)* *LO 5.2: : Apply basic principles to solve exterior lighting design problems using lumen method (PI-1.4.1)* *LO 5.3: Extract engineering requirements from relevant engineering Codes and Standards for exterior lighting design for various applications (PI-3.1.4, PI-6.2.1)* *LO 5.4: Determine design objectives, functional requirements and arrive at specifications for exterior lighting design applications for sustainable development (PI-3.1.6, 6.3.4)*	
06.	**Lighting Control and Recent trends in Lighting**	**06-07**
	Learning Objective/s: *To impart knowledge on lighting control and recent trends in lighting using codes and standards.*	

	Contents: Introduction to Lighting Control, Controls, Selection of Lighting Controls, Lighting Control Schemes, Lighting and LEED, Daylighting control, Controlling LED Lighting Systems, Smart Lighting Fixtures, Digital Lighting Networks, DMX control, Smart Street Lighting with Remote Monitoring and Control System, Solar Powered LED Lighting, Lighting for health and safety, Circadian Rhythm and Human Centric Lighting.	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify existing processes/solution methods of lighting control schemes and digital lighting networks for health and safety (PI-2.2.3)* *LO 6.2: Compare and analyse alternative solution of lighting control schemes using energy using efficient lighting system (PI-2.2.4)* *LO 6.3: Extract engineering requirements from relevant engineering codes and standards, recognize the need and keep current regarding new developments of lighting control schemes and digital lighting networks for health and safety (PI-3.1.4, 6.2.1,11.2.1)* *LO 6.4: Determine design objectives, functional requirements and arrive at specifications and of lighting control schemes using energy using efficient lighting system and digital lighting networks for sustainable development (PI-3.1.6, 6.3.4,11.2.2)*	
	Course Conclusion Lighting is the deliberate use of light to achieve aesthetic effects. Lighting includes the use of both artificial light sources like lamps and light fixtures, as well as natural daylight. Proper lighting can enhance task performance, improve the appearance of an area and have positive psychological effects on occupants.	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.2.1	Apply laws of natural science to an engineering problem
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.3	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.
3.1.4	Extract engineering requirements from relevant engineering Codes and Standards such as ASME, ASTM, BIS, ISO and ASHRAE.
3.1.6	Determine design objectives, functional requirements and arrive at specifications
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
6.3.4	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes:

Learner will be able to

1. Apply basic principles to solve problems on illumination for designing lighting systems *(LO 1.1, LO 1.2,LO 1.3, LO 1.4).*
2. Identify lighting components, control gear for various lamps, and analyse their characteristics for designing lighting systems *(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO3.3, LO3.4).*
3. Apply basic principles to solve problems on interior and exterior lighting design *(LO 4.1, LO 4.2, LO 5.1, LO 5.2).*
4. Determine design objectives, functional requirements for interior and exterior lighting applications through codes and standards and keep current regarding new developments in lighting design (*LO 4.3, LO 4.4, LO 5.3, LO 5.4)*.
5. Identify and analyse lighting control schemes through codes and standards for sustainable development using energy using efficient lighting system *(LO6.1, LO6.2, LO6.3,LO 6.4, LO6.5)*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC6021.1	3	3									
EEPEC6021.2	3	3	3			3					
EEPEC6021.3	3										
EEPEC6021.4			3			3					
EEPEC6021.5		3	3			3					3
Average	**3**	**3**	**3**			**3**					**3**

Text Books :

1. Anil Valia, Designing with Light – A Lighting Handbook, International Lighting Academy
2. M. Nisa Khan, Understanding LED Illumination, CRC Press 2013
3. Anil Valia, LED LIGHTING SYSTEMS All you need to know, International Lighting Academy
4. National Lighting Code- 2011
5. Kao Chen, Energy Management in Illumination Systems, CRC Press.
6. John L. Fetters, The Hand Book of Lighting Surveys and Audits, CRC Press.

Reference Books :

1. Illuminating Engineering Society—The IES Lighting Handbook, 10th Edition
2. J. L. Lindsey and S. C. Dunning —Applied Illumination Engineering, Third Edition, Fairmont Press, 2016
3. Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition
4. Lighting for health and safety – N.A. Smith, Butterworth-Heimann.
5. Human Factors in Lighting – Peter R. Boyce, Taylor & Francis.

Other Resources :

1. NPTEL Course: Illumination Engineering, Prof. N.K. Kishore, IIT Kharagpur https://archive.nptel.ac.in/courses/108/105/108105060/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - MCQ: 10 Marks
   - Class test: 05 marks
   - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
PEC	EEPEC6022	HIGH VOLTAGE DC TRANSMISSION	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. EEPCC301- Engineering Mathematics-III
2. EEPCC302-Circuit and Signal Analysis
3. EEPCC405-Engineering Mathematics-IV
4. EEPCC406-Control System
5. EEPCC408-Powersystem Engineering
6. EEPCC407-Power Electronics

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO6: The engineer and the World
5. PO11: Lifelong learning

Course Objectives:

1. To learn the advantages, disadvantages, applications, classification and components of HVDC system
2. To study the modelling of the complete equivalent circuit of HVDC system and analyse its operation under various conditions.
3. To learn the control of HVDC system under normal and abnormal condition.
4. To learn the faults in HVDC transmission and the protections methods.
5. To acquire the knowledge of the impact of HVDC to the power system and the mitigation methods.

Module	Details	Hrs
	Course Introduction Early discoveries and evolution of HVDC system. Advances in HVDC transmission and its application.	**01**
01.	***Learning Objective:*** *To learn the fundamentals of electrical engineering to identify suitable transmission systems based on applications, Prioritizing Public Safety Considerations.*	**04-06**
	Contents: Introduction Comparison of HVAC and HVDC transmission. Classification of HVDC links, Components HVDC Transmission system, Ground Return Advantages and Problems.	

	Learning Outcomes: *A learner will be able to* *LO1.1 Apply electrical engineering concepts to understand the limitation and advantages of AC and DC transmission. (P.I.-1.3.1)* *LO1.2 Use core principles of engineering to understand components and classification of HVDC system and describe the cares taken to prevent touch and step potential (PI-1.4.1, PI-6.1.1)*	
02.	**Analysis of the Bridge rectifier**	**12-14**
	Learning Objective: *To formulate the equivalent circuit model of a complete HVDC system from the model of rectifier side and inverter side and analyze the performance of converters under different operating conditions*	
	Contents: Analysis of simple rectifier circuits, Features required for an HVDC converter, Analysis of six pulse converter with grid control but no overlap, Analysis of six pulse converter with grid control and overlap less than 60°, Relation between AC and DC quantities, Analysis with overlap greater than 60°, Rectifier operation, output voltage, valve voltage waveforms, Inverter operation, output voltage waveforms, valve voltage waveforms. Equivalent circuit, Multi bridge converter, Numerical from converter circuits and multiple bridge converters.	
	Learning Outcomes: *A learner will be able to* *LO2.1: Apply the electrical engineering knowledge to understand the operation of three phase converter/inverter. (P.I.-1.3.1)* *LO2.2: Apply advanced mathematical concepts to develop the equivalent circuit of HVDC system. (P.I.-1.1.1)* *LO2.3: Identify assumptions necessary to allow modeling of an HVDC system and analyse the complete model and develop relation between AC and DC quantities. (P.I.-2.3.2)* *LO2.4: Analyse HVDC mathematical models to find the electrical parameters of converter and inverter side (P.I.-2.4.1)* *LO2.5: Analyze raw data from HVDC systems, synthesize key insights, and draw meaningful conclusions to enhance understanding of system performance and behavior (P.I-4.3.3, P.I-4.3.4)*	
03.	**HVDC System Control**	**09-11**
	Learning Objective: *To comprehend HVDC operation under normal and abnormal conditions from control characteristics*	
	Contents: Desired features of control, Basic means of control, Limitation of manual control, Constant current verses constant voltage control, Actual control characteristics, Significance of current margin, Power reversal, Control implementation, Converter Firing Control Schemes (EPC and IPC). Energization and de-energization of HVDC link, Starting and shutting down the HVDC link	
	Learning Outcomes: ***A learner will be able to***	

	LO3.1: Apply the electrical engineering knowledge to understand the requirement for rapid control in HVDC and various firing control scheme (P.I- 1.4.1) *LO3.2: Apply advanced mathematical concepts to develop the control characteristics of HVDC system under normal and abnormal condition. (P.I.-1.1.1)* *LO3.3: Analyse the control of HVDC under steady state and transient condition using control characteristics . (P.I.-2.1.3)* *LO3.4: Construct control characteristics for power reversal and analyze the shift of operating point under power flow reversal. (P.I.-2.2.3)*	
04.	**Faults and protection** ***Learning Objective:*** *To study various faults in HVDC transmission and analyse the causes and effects of faults, also identify suitable protection schemes suitable for each fault* **Contents:** Converter faults, By pass valve, single commutation failure, double commutation failure, DC reactor and damper circuits, short circuits in converter station, System protection ***Learning Outcomes:*** *A learner will be able to* *LO4.1: Apply the electrical engineering knowledge to understand the causes and effect of various faults (P.I- 1.4.1)* *LO4.2: Apply fundamental mathematical concepts to differentiate the over current, over voltages and short circuits condition. (P.I.-1.1.1)* *LO4.3: Analyse the operation of bypass valve as a protection circuit in converter valve faults(P.I.-2.1.3)* *LO4.4: Articulate the causes and analyse the effect of commutation failure with the help of circuit diagram and phase voltage, line voltage, line current waveforms. (P.I.-2.2.3)*	**07-09**
05.	**Harmonics & Filters** ***Learning Objective:*** ***To formulate the state variable models, identify the eigen values and use it to analyze the system behaviour*** **Contents:** Harmonics, Causes, Consequences, Means of Reducing Harmonics, Filters, AC & DC Filters *Self-Learning Topics: Filter design* ***Learning Outcomes:*** *A learner will be able to* *LO5.1: Apply the electrical engineering knowledge to understand the causes and effect of harmonics (P.I- 1.4.1)* *LO5.2: Apply fundamental mathematical concepts to differentiate the characteristic and non-characteristic harmonics. (P.I.-1.1.1)* *LO5.3: Synthesize source current and load current of a converter using Fourier analysis to showcase the order of harmonics in the input and output side of HVDC system(P.I.-2.2.3)*	**03-05**

	LO5.4: Identify suitable filter and analyze its impact on system performance. (P.I.-2.1.2) *LO5.5: Recognize the need and be able to clearly explain why it is vitally important to know the causes, effect of harmonics and the methods to minimize it. (PI 11.2.2)*	
06.	**Multi terminal HVDC system and its Application**	**03-05**
	Learning Objective: *To acquire the electrical engineering concepts to understand Modern trends in HVDC transmission*	
	Contents: Multi terminal HVDC system, HVDC light, HVDC system in wind power generation, Modern trends in HVDC transmission.	
	Self-Learning Topics: Power flaw in AC-DC system	
	Learning Outcomes: *A learner will be able to* *LO6.1: Apply the electrical engineering knowledge to understand the operation multi terminal HVDC system (P.I- 1.4.1)* *LO6.2: Apply advanced mathematical concepts to develop the model of HVDC system in wind power application (P.I.-1.1.1)* *LO6.3: Submits a report or delivers a presentation analyzing advancements in HVDC Transmission Systems, and the need of using HVDC in wind power generation (PI-11.2.1, PI-11.3.1)*	
	Course Conclusion The need and effectiveness of HVDC transmission based on the application, implementation, impact on power system and selection of suitable transmission based on application	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems
1.4.1	Apply electrical engineering concepts to solve engineering problems.
1.3.1	Apply fundamental engineering concepts to solve engineering problems
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions

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

11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

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

Course Outcomes:

1. Apply the fundamentals of engineering concepts to identify the application of HVDC transmission, components and classification of HVDC system and safe grounding methods to prevent hazards..(LO1.1, LO1.2)
2. Formulate mathematical models for HVDC transmission system and analyse its performance under various operating conditions. (LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)
3. Apply engineering mathematics to develop control characteristics for HVDC converters and analyse its operation under normal and abnormal conditions. (LO3.1, LO3.2, LO3.3, LO3.4)
4. Analyse the causes and effects of faults in HVDC system and operation of protection schemes. (LO4.1, LO4.2, LO4.3, LO4.4)
5. Analyze HVDC advancements and the impact of harmonics, including causes, effects, and mitigation, through reports and presentations. LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO6.1, LO6.2, LO6.3)

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC6022.1	3					2					
EEPEC6022.2	3	3		3							
EEPEC6022.3	3	3									
EEPEC6022.4	3	3									
EEPEC6022.5	3	3									3
Average	3	3		3		2					3

Text Books:

1. Edward Wilson Kimbark, Direct Current Transmission, Wiley publication Interscience
2. K R Padiyar, HVDC power transmission systems, second edition, New Age International Ltd
3. S. Kamkshaiah and V Kamraju, HVDC transmission, Tata McGraw Hill, New Delhi
4. S.N. Singh, Electric Power Generation, Transmission and Distribution, PHI, New Delhi, 2nd edition, 2008

Reference Books:

1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publication, 1990
2. J. Arrillaga, HVDC Transmission, Wiley publication Inter science
3. C.L. Wadhwa, Electrical Power System (2nd Edition)

Other Resources:

1. NPTEL Course: High Voltage DC Transmission, by Dr. S.N. Singh, IIT Kanpur http://nptel.iitm.ac HVDC.in youtube.com

youtube.com

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)
   Suggested breakup of distribution
   01 MCQ test + 01 Class test: 10 Marks
   Flip class room: 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
PE	EEPEC6023	ADVANCED CONTROL 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. EEPCC406 –Control System

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool usage
5. PO8: Individual and Collaborative Team work
6. PO11: Life-long learning

Course Objectives :

1. To impart the knowledge on fundamentals of compensators and its physical realization.
2. To familiarize the design procedure of compensators to meet the desired transient and steady state error performance specifications using bode plot and state space techniques.
3. To impart knowledge on fuzzy logic and genetic algorithm to solve real-world control and optimization problems.
4. To introduce mathematical techniques to formulate and analyze the given system in digital form.

Module	Details	Hrs
	Course Introduction Introduction to compensators, basic concept of compensator design, its requirement, importance with an electrical closed loop system.	**01**
01.	**Introduction to the Compensators**	**05**
	Learning Objective/s: *To provide the knowledge on the fundamentals of compensators and its physical realization to realize a suitable compensator for real life applications.*	
	Contents Basic concepts of active and passive compensators, cascade and parallel compensators, proportional, derivative, integral compensators, lag, lead and lag-lead compensators, physical realization of compensators with passive and active components, manual and Ziegler-Nichols tuning methods, application with electrical system.	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply fundamental engineering concepts to understand the importance of compensators in control system. (P.I.-1.3.1)* *LO1.2: Identify the active/passive compensator required to improve the desired steady state / transient response. (P.I.-2.1.2)*	

	LO1.3: Use electrical engineering concepts to determine the physical realization for various active/passive compensators as per the desired response. (P.I.-1.4.1) *LO1.4: Compare the performance of PI and Lag compensator / PD and lead compensator/ PID and Lag-Lead compensator to achieve the desired response. (P.I.-2.2.4)*	
02.	**Design of Compensators using Frequency Response Technique (Bode Plot)**	**09**
	Learning Objective: *To provide knowledge on designing compensators using open-loop frequency response parameters from the Bode plot to achieve the desired transient and steady-state error specifications.*	
	Contents: Relation between closed-loop time response parameters of peak time, settling time, and percent overshoot with the open-loop frequency response parameters, transient response improvement by gain adjustment, design of lag, lead and lag-lead compensators using bode plots, application of bode plot compensator design in electrical systems.	
	Learning Outcomes: *A learner will be able to* *LO2.1: Apply engineering mathematical skill to analyze the transient parameters of the given system using open loop frequency response parameters from the bode plot. (PI-2.4.1)* *LO2.2: Determine suitable gain of the compensator using bode plot to yield a specific transient response for the given system. (PI-2.4.2)* *LO2.3: Determine the desired open-loop frequency response parameters from the closed loop time domain parameters, and then design suitable compensators to meet the requirements for the given system. (PI-3.1.6)* *LO2.4: Develop a suitable algorithm and design a compensator to achieve the desired response using the frequency response based tool, called bode plot (PI-3.2.1)* *LO2.5: Collaboratively design and analyze an electrical system using Bode plot, using a suitable simulation tool, demonstrating effective leadership skill and problem-solving strategies. (PI-5.1.1, PI-8.2.1)* *LO2.6: Adapt the simulation tool to model the given electrical system, analyze its performance, design a suitable compensator to achieve the desired response using bode plot and present the result as a group, combining everyone's work into a clear and well-organized presentation. (PI-5.1.2, PI-8.3.1)*	
03.	**Design of Compensators using State variable approach**	**10**
	Learning Objective: *To provide knowledge on designing controllers and observers using state-space techniques to achieve the desired transient and steady-state error specifications.*	
	Contents: State space modelling of electrical systems, different state space representation, design of state feedback controllers, controllability, application of similarity transforms for controller design, observability, state estimators/observers, application of similarity transform for observer design. Integral controller design using state space, application of state space controller design in electrical systems.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply mathematical skill to determine the transformation matrices to convert the given cascade/ parallel/ representation into a suitable representation for the controller/ observer design. (PI-2.4.1)*	

	LO 3.2: Determine suitable gain of the controller using state space technique to yield a specific transient response for the given system. (PI-2.4.2) *LO 3.3: Develop an algorithm and design a controller/ observer to achieve the desired response if the plant is represented in cascade/ parallel representation of state space. (PI-3.2.1)* *LO 3.4: Determine the desired pole locations / requirement of observer / integral controller and then determine the suitable controller/ observer gains to meet the requirements for the given system. (PI-3.1.6)* *LO 3.5: Collaboratively design and analyze an electrical system using state space, using a suitable simulation tool, demonstrating effective leadership skill and problem-solving strategies. (PI-5.1.1, PI-8.2.1)* *LO 3.6: Adapt the simulation tool to model the given electrical system, analyze its performance, design a suitable compensator to achieve the desired response using state space, and present the result as a group, combining everyone's work into a clear and well-organized presentation. (PI-5.1.2, PI-8.3.1)*	
04.	**Approaches to intelligent control**	**06**
	Learning Objective: *To impart the knowledge on basic concepts and principles of fuzzy logic to design fuzzy logic controllers for the given control applications.*	
	Contents: Introduction to fuzzy logic, fuzzy sets and membership functions, fuzzification, inferencing and defuzzification, fuzzy knowledge and rule based inference systems, fuzzy logic controller design, fuzzy logic application in control system.	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply fundamental engineering concepts to formulate the fuzzy rules, identify a suitable membership function etc. for the given problem. (PI-1.3.1)* *LO4.2: Determine design objectives, corresponding fuzzy sets and rules and design a suitable fuzzy logic controller for the given application (PI-3.1.6)* *LO4.3: Apply fuzzy logic with variations in fuzzy subsets/ membership functions/ defuzzification process to develop multiple engineering design solutions (PI-3.2.1)* *LO4.4: Identify few literatures in the relevant field and interpret it effectively for the given problem. (PI 11.3.1)* *LO4.5: Review at least one research paper and applies the knowledge to ensure that it is practical, effective, and sustainable for the given problem. (PI 11.3.2)*	
05.	**Genetic Algorithm**	**06**
	Learning Objective: *To provide knowledge of the fundamental concepts of genetic algorithms and related optimization techniques for solving control and optimization problems.*	
	Contents: Basic concept of genetic algorithm, concept of genes, chromosomes, population, fitness function, crossover and mutation, detailed algorithmic steps, adjustment of free parameters, solution of typical control problems using genetic algorithm, concept on similar search techniques like simulated annealing, particle swarm optimization for solving optimization problems.	
	Learning Outcomes:	

	A learner will be able to *LO5.1: Apply fundamental engineering concepts to identify the selection of various parameters such as genes, chromosomes, mutation/ crossover probability, termination criteria, fitness function etc. for the given problem. (PI-1.3.1)* *LO5.2: Apply genetic algorithm with variations in fitness calculation or crossover/ mutation operations to develop multiple optimum solution. (PI-3.2.1)* *LO5.3: Determine design objectives, corresponding parameters such as initial population, fitness function, refining process to generate the new population etc. to converge the iteration process to an optimum solution for the given application (PI-3.1.6)* *LO5.4: Identify few literatures in the relevant field and interpret it effectively for the given problem. (PI 11.3.1)* *LO5.5: Review at least one research paper and applies the knowledge to ensure that it is practical, effective, and sustainable for the given problem. (PI 11.3.2)*	
06.	**Digital control System** ***Learning Objective/s:*** *To provide knowledge on applying mathematical techniques to formulate and analyze systems in digital form.* **Contents:** Advantage of digital control, components of digital control system, stability of digital system on z-plane, steady state error and error constants, transient response on z-plane, design of digital compensators using bilinear transformation, implementing the digital compensator. ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply electrical engineering concepts to model the components in digital control system (PI-1.4.1)* *LO6.2:* Apply fundamental engineering concepts to model a sampled data system *(PI-1.3.1)* *LO6.3: Apply mathematical and computational skill to analyse the sampled-data transfer functions and determine the range of gain/ sampling rates for stability. (PI-2.4.1)* *LO 6.4: Construct and interpret a basic Routh array to analyze the system for its stability. (P.I.-2.4.2)* *LO 6.5: Determine the steady-state error constants and error specification for the given digital system and use this information to analyze the steady state behavior of the system. (PI-2.4.1)* *LO 6.6: Apply bilinear transformation to formulate a digital compensator and realize it using a suitable flow chart. (PI-2.4.1)*	**07**
	Course Conclusion The course concludes with a comprehensive understanding of compensators and their design using tools such as Bode plots and state-space techniques to enhance system performance. Additionally, the integration of fuzzy logic and genetic algorithms helps learners to tackle complex optimization and control challenges in real-world applications.	**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
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.1	Apply engineering mathematics and computations to solve mathematical models
2.4.2	Produce and validate results through skillful use of contemporary engineering tools and models
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
5.1.1	Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend 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
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 fundamental engineering concepts to identify a suitable controller for the given problem by selecting appropriate parameters and utilizing techniques such as fuzzy logic and genetic algorithm. *(LO1.1, LO1.2, LO1.3, LO1.4, LO4.1, LO5.1)*
2.	Analyze the given system and design a suitable compensator to achieve the desired performance using bode plot and state space technique. *(LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO3.3, LO3.4)*
3.	Design suitable controllers for a given system to achieve the desired response, enabling them to address real-world control and optimization challenges effectively. *(LO4.2, LO 4.3, LO4.4, LO4.5, LO5.2, LO 5.3, LO5.4, LO5.5)*
4.	Develop mathematical models for digital control systems and analyze their behavior based on system response. *(LO6.1, LO6.2, LO6.3, LO6.4, LO6.5)*
5.	Use an appropriate simulation tool to design and analyze the performance of the controller or compensator using Bode plot and state-space techniques, and present the results as part of a team activity. *(LO2.5, LO2.6, LO3.5, LO3.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC6023.1	3	3									
EEPEC6023.2		3	3								
EEPEC6023.3			3								3
EEPEC6023.4	3	3									

EEPEC6023.5					3			3			
Average	3	3	3		3			3			3

Text Books :	
1.	Norman S. Nise, Control Systems Engineering, Seventh Edition, 2015, John Wiley & Sons
2.	Wilkie J., Johnson M., Katebi R., Control Engineering: An Introductory Course, Palgrave MacMillan
3.	Richard C Dorf, Robert H Bishop, Modern Control Systems, Twelfth edition, 2021, Pearson.
4.	G.F. Franklin, Feedback control of Dynamic System, Eighth Edition, 2021, Pearson higher education
5.	Enrique Trillas Ruiz and Luka Eciolaza, Fuzzy Logic: An Introductory Course for Engineering Student, Springer.
6.	S. N. Sivanandam , Introduction to Genetic Algorithms, Springer.

Reference Books :	
1.	S. K. Bhattacharya, Control Systems Engineering, Second Edition, 2015, Pearson.
2.	Curtis Johnson, Control Systems Technology, Heidar Malki, 2002, Pearson
3.	Agoston E. Eiben, J.E. Smith, Introduction to Evolutionary Computing (Natural Computing Series), Springer
4.	Eyal Wirsansky, Hands-On Genetic Algorithms with Python, Packt Publishing.
5.	Benjamin C. Kuo, Digital Control Systems, Oxford series 2nd Edition

Other Resources :
NPTEL Course: Advanced Linear Continuous Control Systems By Prof. Yogesh Hote, Dept. of Electrical Engineering, IIT Roorkee:- Web link- https://nptel.ac.in/courses/108/107/108107115/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

- Case Study assignment: 10 Marks
- Open book test/Open note test: 05 marks
- Regularity and Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)

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

END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
LBC	EELBC608	DRIVES AND CONTROL LABORATORY	01

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. EEPCC406: Control System
2. EEPCC407: Power Electronics
3. EEPCC509: Electrical Machines

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering tool usage
4. PO8: Individual and Collaborative Team work
5. PO11: Life-long learning

Course Objectives: To impart knowledge on

1. various subsystems of electrical drives.
2. transient and steady state analysis of electrical drives.
3. simulation, analysis and implementation of Electrical drives.

Module	Details	Hrs
	Course Introduction The drives are essential in industries and electric vehicles, enabling efficient motion control. Hence hands-on experience with electrical drives and control is crucial for electrical engineers. Mastering DC and AC drive modeling, simulation, and implementation is key for understanding advanced motor control. Additionally, programming drives and integrating them with PLCs is vital for industrial automation.	
01.	***Learning Objective:*** *To acquire skill to use simulation/hardware tools to analyze the performance of DC/AC machines.*	**06**
	Theme for conducting experiments: 1. Analyze the performance of DC/AC machine using its dynamic model (Simulation).	
	Learning Outcome: *A learner will be able to* *LO1.1: Use simulation tools, such as Simulink, to model DC and three-phase induction motors, analyze their performance, and assess transient operations (PI 2.1.2, 2.2.2, 5.2.1, 5.2.2)*	
	Theme for conducting experiments: 2. Analyze the dynamics of DC/AC motor during starting and braking (experiments).	
	Learning Outcome: *A learner will be able to* *LO1.2: Collaboratively conduct hardware experiments on DC shunt and induction motors to analyze transient operations during starting and braking phases, apply appropriate testing procedures, ensure safety precautions, collect and represent data in*	

	tabular/graphical forms, and interpret results for performance analysis ***(PI 2.2.3, 2.4.4, 4.1.3, 4.3.3, 8.2.1, 8.2.2)***	
02.	***Learning Objective:*** *To acquire skill on implementation of speed control schemes of DC drives.*	**08**
	Theme for conducting experiments: 3. Analyze the speed control methods of DC motor by simulation.	
	Learning Outcome: *A learner will be able to* *LO2.1: Use simulation tools, such as Simulink, to model chopper-fed separately excited DC motors, analyze their performance under various conditions by plotting and interpreting waveforms (PI 2.2.2, 2.2.3, 5.2.1, 5.2.2).*	
	Theme for conducting experiments: 4. Implement subsystems of DC drive.	
	Learning Outcome: *A learner will be able to* *LO2.2: Collaboratively design and implement simple sub-systems (power/control/sensor circuits) of a DC motor drive, demonstrating an understanding of their integration and functionality in speed control applications. (PI 2.2.2, 2.2.3, 8.2.1, 8.2.2)*	
	Theme for conducting experiments: 5. Analyze the speed control methods of DC motor experimentally.	
	Learning Outcome: *A learner will be able to* *LO2.3: Conduct experimental analysis of DC motor speed control schemes, represent performance data in tabular and graphical forms, and produce a clear, well-supported report with appropriate conclusions based on the analysis of performance characteristics. (PI 2.2.2, 2.2.3, 4.3.3, 4.3.4, 8.2.1, 8.2.2)*	
03.	***Learning Objective:*** *To acquire skill on implementation of speed control schemes of AC drives.*	**09**
	Theme for conducting experiments: 6. Analyze the speed control methods of AC motor by simulation.	
	Learning Outcome: *A learner will be able to* *LO3.1: Use simulation tools to model PWM-based inverter-fed induction motors and analyze the performance of stator voltage and/or V/f speed control methods by observing and interpreting relevant waveforms. (PI 2.2.2, 2.2.3, 11.3.1, 11.3.2)*	
	Theme for conducting experiments: 7. Implement subsystems of AC drive.	
	Self-Learning Topics: *Application reports for the implementation of V/f speed control and Field oriented control of induction motor, provided by Texas Instruments, Infineon Technologies etc.*	
	Learning Outcome: *A learner will be able to* *LO3.2: Collaboratively design and implement simple sub-systems (power, control, and sensor circuits) of an AC motor drive, demonstrating an understanding of their integration and role in speed control applications. (PI 2.2.2, 2.2.3, 8.2.1, 8.2.2)*	
	Theme for conducting experiments: 8. Analyze the speed control methods of AC motor experimentally.	
	Learning Outcome: *A learner will be able to* *LO3.3: Experimentally analyze AC motor speed control schemes by observing relevant waveforms, representing the data in tabular and graphical forms, and producing a clear, well-supported report with appropriate conclusions based on performance characteristics. (PI 2.2.3, 2.4.4, 4.3.3, 4.3.4, 8.2.1, 8.2.2)*	

04.	***Learning Objective:*** *To acquire skill on programming of AC drive and interfacing it with PLC.*	**07**
	Theme for conducting experiments: 9. Programming the basic AC industrial drive.	
	Learning Outcome: *A learner will be able to* *LO4.1: Perform the connections for the control and power circuits of an AC drive and program the drive according to various application requirements by referring to the user manual. (PI 2.2.2, 2.2.3, 11.3.1, 11.3.2)*	
	Theme for conducting experiments: 10. Interfacing AC Drive with PLC for Automation	
	Learning Outcome: *A learner will be able to* *LO4.2: Interface the AC drive with a PLC and develop appropriate programs for both systems to achieve the desired automation requirements. (PI 2.1.2, 2.2.3, 11.3.1, 11.3.2)*	
	Minimum 2 experiments from each module, and total at least 10 experiments	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.2	Identify, assemble and evaluate information and resources.
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
4.3.3	Represent data in tabular and/or graphical forms so as to facilitate analysis and explanation of the data, and drawing of conclusions
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
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.
5.2.2	Demonstrate proficiency in using discipline specific tools.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.2.2	Treat other team members respectfully.
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:

Learner will be able to

1. Analyse the transient operation of a drive in different modes of operation (*LO1.1, LO1.2).*
2. Analyse the speed control schemes of DC and AC drives through simulation and experimental investigation (*LO2.1, LO2.3, LO3.1, LO3.3).*
3. Implement simple sub-systems of DC/AC motor drives in a team (*LO2.2, LO3.2).*
4. Program a basic AC industrial drive using the manual and integrate it with a PLC for automated control (*LO4.1, LO4.2).*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELBC608.1		3		3	3			3			
EELBC608.2		3		3	3			3			
EELBC608.3		3		3							3
EELBC608.4		3									3
Average		3		3	3						3

Text Books:

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. A First Course on Electrical Drives by S. K. Pillai, New Age International.
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR

Reference Books:

1. Electric Motor Drives: Modelling, Analysis and Control by Krishnan R, PHI
2. Power electronics by Muhammad H. Rashid, Pearson

Other Resources :

1. NPTEL Course: Fundamentals of Electric Drives, IIT Kanpur by Prof. Shyama Prasad Das https://nptel.ac.in/courses/108/104/108104140/
2. NPTEL Course: Industrial Drives - Power Electronics, IISc Bangalore by Prof. K. Gopakumar. https://nptel.ac.in/courses/108/108/108108077/
3. NPTEL Course: Industrial Drives, IIT Delhi by Dr.K .R. Rajagopal https://nptel.ac.in/courses/108/102/108102046/
4. Application reports for the implementation of V/f control and indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Practical Exercises- 10 Marks
- Internal Assessment - 10 Marks
  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory sessions.
- Regularity and active participation - 05 Marks

END SEMESTER ASSESSMENT (Practical and Oral Examination) (25 Marks)

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

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

Course Type	Course Code	Course Name	Credits
LBC	EELBC609	ELECTRICAL SOFTWARE LABORATORY	01

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. EEPCC303: Electrical Power System
2. EESBL301: Python Laboratory
3. EEPCC407: Power Electronics

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering tool usage
4. PO9: Communication
5. PO11: Lifelong learning

Course Objectives:

1. To impart knowledge on development of AI-based solutions for electrical engineering challenges using Python and machine learning to enhance performance and decision-making..
2. To gain expertise in power electronics focusing on their application in energy-efficient technologies like electric vehicles.
3. To model electrical systems, including lighting and HVDC, with advanced controls to improve efficiency and reliability.
4. To impart knowledge on electromagnetic analysis of electrical/electronic devices and systems using suitable simulation software.

Module	Details	Hrs.
	Course Introduction This course provides a comprehensive exploration of AI-based solutions and advanced simulation techniques for solving complex electrical engineering problems. By leveraging Python and cutting-edge AI methodologies, students will develop intelligent models for fault detection, performance optimization, and predictive maintenance in electrical systems. Additionally, the course covers power electronics, control strategies, and electromagnetic field analysis using simulation software. Through hands-on experiments and real-world applications, learners will gain practical expertise in data collection, AI model development, system simulation, and performance evaluation. This course equips students with the skills needed to integrate AI and simulation tools into modern electrical engineering applications.	**01**
01.	***Learning Objective:*** ***To impart knowledge on development of AI-based solutions to address complex problems in electrical engineering, leveraging the power of Python software and AI techniques.***	**06**
	Contents/Experiments: Develop AI based solutions using python software for various complex problems in electrical engineering. **Theme for experiment:**	

	1. Classifying data and predict Electrical devices/system performance using different Python based AIML algorithms. ***Learning Outcome:*** *A learner will be able to* *LO1.1: Collect, preprocess, and interpret data using simulations, experiments or historical records. Also identify and develop AI models, train and fine-tune them using Python to achieve required accuracy, and integrate them with Electrical Engineering systems. Additionally, perform model evaluation, technical documentation, and independent learning through research and experimentation. (PI- 2.1.1, 2.3.1, 2.4.1, 4.1.3, 4.3.1, 5.1.1, 5.3.2, 9.1.1, 9.1.2, 11.3.1, 11.3.2)*	
02.	*Learning Objective:* ***To acquire knowledge and skills in simulating and analyzing power electronic converters in various domains including electric vehicle technology.***	**8**
	Contents/Experiments: Use simulation software to analyze the characteristics of power electronic systems and its applications in various domains including electric vehicle technology under various operating conditions, employing appropriate system models with and without control algorithms to optimize performance. **Theme for experiment:** 1. Simulating power electronic converters and analyzing their performance under different conditions. ***Learning Outcome:*** *A learner will be able to* *LO 2.1: Implement power electronic system models using simulation software, identify control algorithms, execute experiments, assess performance accuracy, and correlate simulation results with expectations. (P.I.- 2.1.1, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2)* 2. Analyzing impact of controllers on performance of power electronic converters. ***Learning Outcome:*** *A learner will be able to* *LO 2.2: Interpret technical data, document the findings and engage in independent research to enhance understanding and propose experimental extensions. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)*	
03.	*Learning Objective:* ***To impart knowledge on electrical systems including Power System, lighting technologies., HVDC technologies and to implement advanced control techniques to enhance their efficiency and reliability.***	**6**
	Contents/Experiments: Use simulation software to develop practical skills in modeling, simulating, and optimizing power systems, lighting solutions, and HVDC transmission networks, while implementing control strategies to improve system performance under varying operational conditions. **Theme for experiment:** 1. Modelling and analyzing electrical power system using simulation software. ***Learning Outcome:*** *A learner will be able to* *LO 3.1: Implement power system models using simulation software, select and apply control algorithms, execute experiments, analyze performance, validate simulation accuracy, and correlate results with expectations, (P.I.- 2.1.1, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2)*	

	2. Implementing control strategies to improve system performance under varying operational conditions. ***Learning Outcome:*** ***A learner will be able to*** *LO 3.2: Interpret technical data, clearly document findings, and explore additional resources for independent learning by proposing new experiments or extending existing investigations. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)*	
04.	***Learning Objectives:* Comprehend electromagnetic effects in electrical/electronic devices and systems using suitable simulation software.**	**8**
	Contents/Experiments: **Use FEMM software to perform experiments on few of following topics:** Electric field between capacitor plates, electric potential and field lines around charges or electrodes, electric field distribution in a system with multiple dielectric layers, magnetic field generated by a straight wire or coil, field distribution around permanent magnets of different shapes, Lorentz force on a wire in a magnetic field, induced EMF in a coil due to a time-varying magnetic field. **Theme for experiment:** 1. Simulation of Electromagnetic Fields and Their Interactions with Materials. 2. Visualizing Electric and Magnetic Fields: Effects of Charges, Conductors, and Dielectrics. *Learning Outcomes:* *A learner will be able to* *LO 4.1: Leverage simulation software to analyze electromagnetic and electrostatic effects on electrical and electronic materials and devices. Identify variables, measure physical quantities, implement experiments, and evaluate results for accuracy. (P.I.- 2.1.1, 2.4.2, 4.1.3, 4.3.1, 5.1.1, 5.3.2)* 3. Analyzing Electromagnetic Field Distribution and Induced Effects in Various Systems. *Learning Outcomes:* *A learner will be able to* *LO 4.2: Interpret technical data, document findings, and explore resources to extend lab knowledge and develop experiments. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)*	
	Course Conclusion The acquired skills in machine learning, power electronics, control systems, and electromagnetic field analysis will enable students to tackle industry-relevant challenges effectively. As they move forward, students are encouraged to continue exploring AI advancements and emerging simulation tools to further refine their expertise and contribute to the evolving field of electrical engineering.	**01**
	Total	**30**

Performance Indicators:

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

2.3.1 Combine scientific principles and electrical engineering concepts to formulate model of a system 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 tools and models

4.1.3 Apply appropriate instrumentation and/or software tools to make measurements of physical quantities

4.1.4 Establish a relationship between measured data and underlying physical principles

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

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

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

9.1.1 Read, understand and interpret technical and non-technical information.

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

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:

Learner will be able to

1. Apply AI techniques and Python programming to solve complex electrical engineering problems using suitable software tool. *(LO 1.1)*
2. Analyze applications of power electronic converters in modern technologies such as electric vehicles for improved efficiency and functionality. *(LO 2.1, LO 2.2)*
3. Implement and analyze electrical power system, energy-efficient lighting system and HVDC technologies using simulation software. *(LO 3.1, LO 3.2)*
4. Analyze electromagnetic behaviours and their effect on performance of Electrical/Electronic devices and systems using suitable simulation software. *(LO 4.1, LO 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELBC609.1		3		3	3				3		3
EELBC609.2		3		3	3				3		3
EELBC609.3		3		3	3				3		3
EELBC609.4		3		3	3				3		3
Average		3		3	3				3		3

Reference Books:

1. *Power Electronics: Converters, Applications, and Design* by Ned Mohan, Tore M. Undeland, William P. Robbins.
2. *Electric Vehicle Technology Explained* by James Larminie and John Lowry.
3. *Power System Analysis* by John J. Grainger and William D. Stevenson.
4. *High Voltage Direct Current Transmission* by Adamson and Hingorani.
5. *Electromagnetic Field Theory* by William Hayt and John Buck.
6. *Artificial Intelligence Techniques in Power Systems* by Kevin Warwick.

Text Books:

1. *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles* by Mehrdad Ehsani et al.
2. *Lighting Handbook* by Illuminating Engineering Society (IES).
3. *Finite Element Method Electromagnetics* by Jian-Ming Jin.
4. *Control Systems Engineering* by Norman S. Nise.
5. *Python Machine Learning* by Sebastian Raschka and Vahid Mirjalili.

Other Resources:

1. NPTEL/SWAYAM Course: https://archive.nptel.ac.in/courses/108/101/108101167/

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

Lab Experiments: 10 Marks

Internal Assessment (Mock practical -5 Marks, Oral 5 Marks): 10 marks

Attendance: 5 marks

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

Drawing circuit/block diagram, Observation Table, Relevant formulae as per aim (5Marks)

Experiment conduction (5Marks)

Sample calculations and Conclusion(5Marks)

Oral: 10 Marks.

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

Course Type	Course Code	Course Name	Credits
SBL	EESBL603	INDUSTRIAL AUTOMATION LAB	02

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
50	50	100

Pre-requisite:

1. EESBL402- PCB Fabrication and Circuit Testing

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Modern tool usage
4. PO7: Ethics
5. PO8: Individual and team work
6. PO11: Life-long learning

Course Objectives:

1. To acquire knowledge about components and subsystems used in industrial automation.
2. To develop the proficiency essential for seamlessly integrating and monitoring subsystems of industrial automation.

Module	Details	Hrs	CO
	Course Introduction In the Industrial Automation Lab course, students will explore the fundamentals of programmable logic controllers (PLCs), IoT, and robotics with a focus on real-world industrial applications. The hands-on experience includes developing and troubleshooting ladder logic programs for PLCs, integrating industrial output field devices, configuring sensor networks, connecting to cloud-based platforms, and working with autonomous systems commonly used in modern manufacturing and process industries.		
01.	**Industrial Automation and Programmable Logic Controller** ***Learning Objective:*** *To impart knowledge on fundamentals of industrial automation, identify PLC hardware components, and develop basic to advanced PLC programs using appropriate instructions and programming techniques for automation applications.*	**22**	CO1
	Content: **Industrial Automation:** Importance of Industrial Automation, Levels of Industrial Automation, Key Components of Industrial Automation, Types of Industrial Automation, Role of Electrical Engineers in Industrial Automation. **PLC Hardware and Programming Basics:** Familiarization of block diagram of a PLC based system, Components of a PLC system, Selection criteria for PLC hardware, PLC wiring and installation considerations, PLC Programming Basics, Introduction to PLC programming languages. Basic programming instructions (Input, Output, Timer, Counter, etc.) **Advanced PLC Programming:** Data manipulation instructions (Math, Compare, Move, etc.), Program control instructions (Jump, Subroutine, etc.), Sequential and combinatorial logic programming, Programming Jump-to-subroutine & return operations in PLC.		
	Theme for Designing Multiple Experiments:		

	Develop and execute PLC ladder logic for various systems like motor control, conveyor belt control, liquid level control, traffic light control with sensors actuators and other control devices.		
	Learning Outcomes: *A learner will be able to demonstrate the ability to design, develop, and implement PLC programs using appropriate hardware, instructions, and programming techniques to meet technical and operational requirements of industrial automation while effectively collaborating in a team environment. (P.I.-2.1.2, P.I.-2.2.2, P.I.- 4.1.4, P.I.- 4.3.1, P.I.-8.1.1, P.I.-11.3.1, P.I.-11.2.2)*		
02.	**Introduction to Internet of Things (IoT) and Robotics** ***Learning Objective:*** *To develop ability to integrate sensor data, connectivity, and autonomous systems to create simple IoT and robotic solutions that enhance automation and decision-making in diverse industrial and everyday environments.*	**20**	CO2
	Content: • **IoT in Industrial Automation:** Concepts of Industrial IoT, its applications, and its significance in modern industrial processes. Integration of different components into a cohesive IoT system and analyse data collected. Hands-on experience in developing elementary IoT solutions using sensors, actuators, microcontrollers, and communication protocols. • **Basic Robot Control:** Control of robotic platforms using manual commands and simple algorithms. Understanding components like actuators, sensors, and controllers that enable robot movement and interaction. Concepts include programming logic, sensor integration, and mechanical design.		
	Theme for Designing Multiple Experiments: Design and development of IoT-based home automation systems with integrated safety and security features, incorporating sensor technology for environment perception, obstacle detection, and navigation. Additionally, development of autonomous navigation algorithms and path planning using sensor data to enhance system intelligence and adaptability.		
	Learning Outcomes: *A learner will be able to* *Apply IoT and robotic system technologies to develop automated solutions for smart manufacturing, integrating sensors, programming logic, and modern engineering tools while collaborating effectively in a team environment. (P.I.-2.1.2, P.I.-2.2.2, P.I.-5.1.1, P.I.- 5.1.2, P.I.-8.1.1, P.I.-8.3.1, P.I.-11.2.1, P.I.-11.3.1)*		
03.	**Integration of IoT and Robotics** ***Learning Objective:*** *To impart ability to design communication and data exchange between smart devices like IoT and autonomous robots, enhancing automation, decision-making, and efficiency in various applications.*	**18**	CO3
	Content: Data Collection and Analysis: Collect sensor data from robotic systems, transmit it to the cloud. Remote Monitoring, Control and Task Automation: Enable remote monitoring and control of robotic systems via IoT platforms allowing for real-time supervision and intervention.		
	Theme for Designing Multiple Experiments: Design and implement automation tasks such as pick-and-place operations or assembly tasks using robotic arms and IoT.		
	Learning Outcomes: *A learner will be able to*		

	Apply data analysis techniques, ethical considerations, and modern IoT tools to implement remote monitoring and control of robotic systems while effectively conducting experiments and collaborating within a team. (P.I.- 4.1.4, P.I.- 4.3.1, P.I.- 7.1.1, P.I.- 7.2.2, P.I.-8.1.1, P.I.- 8.2.1, P.I.- 11.2.2)		
		60	

Performance Indicators:

P.I. No.	**P.I. Statement**
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.
2.2.2	Identify, assemble and evaluate information and resources.
2.3.1	Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy.
4.1.4	Establish a relationship between measured data and underlying physical principles.
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data.
5.1.1	Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.1.2	Adapt the tools and techniques to solve engineering problems.
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
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem solving, and conflict resolution and leadership skills.
9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes:

Learner will be able to

1. Integrate and interface components and subsystems used in industrial Automation using PLC.
2. Design /implement basic IoT and robotic systems for simple applications.
3. Design various components and subsystems used in industrial automation, and understand their integration within complete automated systems.

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EESBL603.1		3		3	3			3			3
EESBL603.2		3			3			3			3
EESBL603.3				3			3	3			2
Average		3		3	3		3	3			3

Text Books:

1. Introduction to programmable logic controllers by Gary Dunning. 2nd edition
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
3. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
4. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
5. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 2000.

Reference Books:

1. PLC Programming for Industrial Automation by K Collins · 2014
2. Adrian McEwen, Hakim Cassimally Designing the Internet of Things , John Wiley, 2014
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
4. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
5. K. K.Appu Kuttan, Robotics, I K International, 2007.
6. Edwin Wise, Applied Robotics, Cengage Learning, 2003.

Other Resources:

1. NPTEL/ Swayam Course: Robotics and Control: Theory and Practice by Prof. N. Sukavanam and Prof.M. Felix Orlando, IIT Roorkee.
   Web Link: https://onlinecourses.nptel.ac.in/noc25_me69/preview

CONTINUOUS ASSESSMENT (50 Marks)

Suggested breakup of distribution

Laboratory Exercises: 15 Marks

Internal Assessment: 10 Marks

As a part of Internal Assessment, students will do course mini project as a team to inculcate teamwork. Students will be tasked with developing a small-scale system using Python. This project-based assessment will require students to apply their knowledge and skills gained throughout the course to design and implement a functional system using PLC, IoT and robotics language.

Course Project Rules:

1. Group Size: Groups of 2 to 4 members allowed.

2. Project Proposal: Detailed proposal with scope, objectives.

3. Project Requirements: Develop using PLC/IoT/Robotics.

4. Presentation:

- Present project features, challenges faced, and solutions.
- Q&A session for evaluation.

5. Evaluation Criteria:

- Adherence to requirements and objectives.
- Effective presentation and Q&A skills.

Regularity and active participation: 05 Marks

Practical Test: (20 Marks)

- Practical Test 1 (Based on first 50% of practical list) – 10 Marks

- Practical Test 2 (Based on remaining 50% of practical list) – 10 Marks

END SEMESTER ASSESSMENT (Practical and Oral Examination) (50Marks)

- Two examiners, one Internal and one External will do the evaluation.
- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 10 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections/simulation and take readings. The connections and output are verified by the examiners. The weightage is 10 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 10 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.

Course Type	Course Code	Course Name	Credits
MNP	EEMNP604	MINI PROJECT- 2B	01

Program Outcomes addressed:

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

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

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

Guidelines for the Mini Project

Mini project may be carried out in one or more form of following:
Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

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

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

Semester V:

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

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

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

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

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
ELC	ELC601	RESEARCH METHODOLOGY	02

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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer & The World.
4. PO7: Ethics
5. PO8: Individual & team work
6. PO9: Communication
7. PO11: Life-long learning

Course Objectives:

1. To gain the knowledge of use research tools and techniques to design research projects and form the hypothesis.
2. To familiarize students about the literature review practice for identifying the research gap.
3. To gain the knowledge about collection of data and qualitative/ quantitative analysis of data and results
4. To understand the key practices in preparation of a research report / paper.
5. To foster ethical practices in research and publications

Module	Details	Hrs
00	**Course Introduction:** This course aims to introduce students to the important aspects of research. The course is intended to make students aware of formal research and to overcome common misconceptions in research that may be present in their minds. At the end of this course, students shall be able to take up research activities in a more systematic and formal manner right from the beginning. This course on Research Methodology learned through experiential learning mechanism can play a significant and holistic role in contributing to the personal and professional development of students.	1
1	**Fundamentals of Research Methodology**	4-5
	Content: Types of Research, Research approaches, Empirical research methods, Significance of research, Research design, Case study method, Sampling technique, Sources of data, Selection of research problem, Research Ethics and Empiricism	

	Exercise: A group discussion on what is research and ethics in research with related case studies shall be conducted.	
2	**Formulation of a Research Problem & Hypothesis formulation**	**4-5**
	Content: Selection and formulation of a research problem, Objectives of formulation, Criteria of a good research problem, Literature Review Process and Formulation of Research Questions Hypothesis-Characteristics and Hypothesis Testing –Logic and Importance *Exercise: Groups of students shall make Technical Presentations on Selection of a research problem and Hypothesis formulations based on topics given.*	
3	**Research Design**	**4-5**
	Content: The Research framework, Research design: Need, Characteristics & Components; Experimental and non-experimental designs, Experimental and non-experimental hypothesis testing. Classification schemes for research design, Principles of experimental designs, Writing rationale for a research *Exercise: Students shall prepare the framework of research methods and techniques to conduct a study on a given real life case study covering key elements of the module.*	
4	**Sampling Method**	**3-4**
	Content: Probability or random sampling, Cluster sampling, Area sampling, Multi-stage sub-sampling, Random sampling with probability proportional to size, Non-probability sampling. *Exercise: A real life case study shall be demonstrated to students covering key elements of the module shall be covered.*	
5	**Data Collection & Data Analysis**	**4-5**
	Content: Sources of data, Collection of data, Measurement and scaling technique, Collection of data from appropriate sources (primary and secondary), Correlation and causation, Classification of quantitative analysis. Selection and analysis of multi-variate methods, Performing data analysis and presentation of results, Case study method. *Exercise: Group of students shall carry out exercise of real life data collection on a given research problem and data analysis and submit the report*	
6	**Report Writing and Journal Publication**	**3-4**

	Content: Preparation of a research report, Formats and Contents of report: Literature review, Presentation of research work, Research Design & Analysis, Results, Findings, and Contribution, Significance of research, and Conclusion. Mechanics of writing papers in Peer-reviewed Journals / Reputed Conferences. Ethics in Publication. *Exercise: Students shall prepare & submit a paper (4-5 pages) in a standard format (suitable universally accepted journal publication format) based on the exercises / research case study carried out in this course.*	
	Course Conclusion	**1**
	Total	**30**

Course Outcome: Learner will be able to

CO1: Identify and demonstrate the importance of research process in science and technology domains
CO2: Perform literature reviews using print and online databases.
CO3: Analyse the data using qualitative and quantitative methods
CO4: Identify and prepare the key elements of a research report/ paper
CO5: Illustrate the rationale for research and publication ethics

Text Books:

1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publisher, 2014.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage Publication, 2018
3. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2014

Reference Books:

1. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Ed., SAGE, 2018.Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2005.
2. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
3. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

Other Resources:

NPTEL Course: Research Methodology By Prof. Edamana Prasad, Prof. Prathap Haridoss (IIT Madras) Weblink https://onlinecourses.nptel.ac.in/noc25_ge28/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6011	ART OF LIVING	02

Program Outcomes addressed:

1. PO6 : The Engineer and The World
2. PO7 : Ethics
3. PO9 : Individual and Collaborative Team work
4. PO9: Communication
5. PO11: Life-long learning

Course Objectives :

1. To provide a comprehensive understanding of the principles of the Art of Living and their relevance to holistic well-being.
2. To equip participants with practical techniques like Sudarshan Kriya, yoga, and mindfulness for stress management and emotional balance
3. To enable participants to apply the Art of Living principles to enhance relationships, productivity, and life purpose.

Module	Details
01.	**Introduction to the Art of Living** Understanding the Mind and Stress, Breath and Life Energy, Basics of Yoga and Guided Meditation
02.	**Sudarshan Kriya and Breathing Techniques** Introduction to Sudarshan Kriya, Practicing Rhythmic Breathing Techniques
03.	**Emotional Well-being** Understanding and Balancing Emotions, Forgiveness and Gratitude Practices, Guided Meditation for Emotional Healing
04.	**Relationships and Social Connections** Compassion and Effective Communication, Stress-free Relationships, Group Activities for Trust and Collaboration
05.	**Living with Purpose and Awareness** Discovering Life Purpose, Mindfulness Practices, Time Management and Productivity
06.	**Sustaining the Practices** Developing a Daily Routine, Advanced Breathing Techniques, Reflections, and Closing Meditation
Total no. of hours: **30**	

Course Outcomes :

1. Gain insights into managing stress and emotions through breathwork and meditation
2. Develop skills for building harmonious relationships and enhancing emotional intelligence.
3. Cultivate mindfulness, compassion, and clarity in daily life.
4. Sustain the Art of Living practices for long-term well-being and self-discovery.

Text Books :

1. "Celebrating Silence" by Sri Sri Ravi Shankar (1999, Sri Sri Publications Trust)
2. "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar (1995, Inner Traditions International)
3. "The Miracle of Mindfulness" by Thich Nhat Hanh (1975, Beacon Press)

Reference Books :

1. "Wisdom for the New Millennium" by Sri Sri Ravi Shankar (2000, Sri Sri Publications Trust)
2. "The Healing Power of the Breath" by Richard P. Brown and Patricia L. Gerbarg (2012, Shambhala Publications)

Course Type	Course Code	Course Name	Credits
LLC	LLC6012	Yoga and Meditation	02

Course Objectives :

1. To raise awareness of the therapeutic and preventive benefits of Yoga and Meditation
2. To nurture Holistic wellness through the harmony of body, mind and self
3. To advocate for the application of Yogic science in the treatment and prevention of psychosomatic and Lifestyle disorders.
4. To inspire the practice of Yogic Science tools for fostering health and well-being in daily life
5. To promote the art of purposeful and mindful living by cultivating a deep sense of oneness with the self, nature and the world.

MODULE	DETAILS
1.	**Introduction to Yoga and Meditation** Definition of Yoga, Importance of Yoga for Human life, Literature of Yoga: Yoga Sutra, Bhagavat Gita – Synthesis of Yoga, Hathapradipika etc. Challenges of health in students & youth - Studies, Yogic concept of Health and Meditation, Concept of Body and Disease in Yoga, Dimensions of Health- Physical, Mental, Social and Spiritual, Different types of yoga (Karma, Gyaan, Ashtanga, Bhakti), Eight limbs of ashtanga yoga.
2.	**Yoga and Wellness** Yoga and Medical perspectives – Health related fitness, Yoga for common ailments, Scientific Researches in Yoga, Yogic anatomy of Human body Asanas – Definitions and classifications, Scientific reasoning behind the asanas, Yoga for Stress, Technostress and Lifestyle management. Mental Disturbances and Preventive, Curative Aspect of Yoga for Mental wellness.
3.	**Essentials of Yoga Practices** Difference between Yoga and Exercise, Obstacles in the path of Yogic Practices, Disciplines in Yogic practices – Prayers, Yama, Niyama, Place, Time, Diet, Schedule, Sequence for Yogic Practices. Yogasanas: Surya Namaskara, Standing asanas and Sitting asanas, Different groups of Yogasanas – Relaxation, Meditative, Digestive etc. Psycho-physiological effects and health benefits of Yogasana, Function and effect of Asanas - Digestive system, Respiratory system, Excretory system, Circulatory system, Nervous system etc.

4.	**Meditation – Role of Breath and Pranayama** Yogic anatomy, Wellness and Triguna system, Science of Pranayama – 'Prana', the vital principle, Prana and air element, Awareness - Breath Awareness, Different types of Breathing, Breath Control, Breath and Postures, Rhythmic Breathing, Pranic body in the five-fold body (Panchakosha), Power of breath, Difference between Pranayama and breathing, Prana and nervous system, Fivefold function of prana, Benefits of pranayama
5.	**Fundamental aspects of Meditation** Pranayama and deep breathing - Concept of Inhalation (Puraka), Retention (Kumbhaka), & Exhalation (Rechaka); Important Pranayamas; Pranayama and Meditation; Mind and Meditation; Inner Instrument – Mind, Constituents of Mind - Mana, Buddhi, Ahankar and Chitta(Consciousness), Magnitude of Mind, Buddhi – the determinative faculty; Body-Mind complex; Mind Cleansing; Yogic Meditation and Mindfulness meditations; Yogic Process and Outcome of Meditation – Pratyahara, Dharana and Dhyana; Scientific studies on Meditation and Healing.
6.	**Meditation Tools and Techniques** Why Meditate - States of Mind, Mind over Body – Processing Thoughts, Preparing for Meditation – Posture, Shanti prayers, Pranayama, Training the Mind: Practicing tools-Bhramari Pranayama, Sacred Pranav (Om) mantra, Mantra Japa/ajapa, Types of Mindfulness Meditations, Yoga Nidra, Body scan meditation, etc. Benefits of Meditation

Course Outcomes:

1. Gain comprehensive insights about the necessity of yoga for daily life.
2. Obtain a simplified understanding of the impact of mindful breathing on health wellbeing.
3. Acquire knowledge of 'practice and principles' of simple awareness meditation for Mental wellness
4. Gain required knowledge to improve overall health and immune system
5. Practice simple asanas and meditation techniques to improve concentration, self- confidence and inner peace

Text Books:

1. Light on the Yoga Sutras of Patanjali by B.K. Iyengar (Publisher: Orient Longman Pvt. Ltd. Mumbai)
2. Pranayama - The Art & Science by Dr. Nagendra H R (Publisher: Swami Vivekananda Yoga Prakashan, Bangalore)
3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Recommended Books

1. Pranayama-Science of Breath by Gharote, M. (Publisher: The Lonavla Yoga Institute, India)
2. Svatmarama's HathaYogaPradeepika by Gyan Shankar Sahay (Publisher: Yogic Heritage, India)
3. Yoga for Health and Peace by Padamshree Sadashiv Nimbalkar (Publisher: Yoga Vidya Niketan, Mumbai)

Other Resources:

1. NPTEL Course: Yoga and Positive Psychology for Managing career and life by Prof.

Ashish Pandey, IIT Bombay.
Weblink https://archive.nptel.ac.in/courses/110/101/110101165/

2. SWAYAM Course: Yoga for Concentration by By Dr H R Nagendra, Dr Manjunath N K and Dr Apar Avinash Saoji from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore. Weblink: https://onlinecourses.swayam2.ac.in/aic23_ge05/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6013	Health and Wellness	02

Course Objectives :

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques

MODULE	DETAILS
1.	**Foundations of Health Well-being** Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche Yogic anatomy of Physiological and Psyche layers, Triguna system
2.	**Physical Wellbeing** Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation
3.	**Emotional Wellness** Types of Emotions, Symptoms of emotional wellness Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc. Emotions and physical wellness Understanding the trinity of senses, sense objects and emotions, Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness
4.	**Mental Wellness** What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety, behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements

5.	**Intellectual Wellness** Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness
6.	**Spiritual Wellness** Yogic understanding of term 'spiritual' Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness Studies on Spiritual wellness and Body Healing Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements

Course Outcome:

1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

Text Books

1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher: Nisargopachar Gramsudhar Trust, Pune)
2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)
3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil
4. V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

Reference books

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)
2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
3. (Publisher: Motilal Banarsidass Publishing House, Delhi)
4. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Other Resources:

1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur. Weblink https://nptel.ac.in/courses/127105236
2. NPTEL Course: The Science of Happiness and Wellbeing by By Prof. Priyadarshi Patnaik, Prof. Manas K. Mandal from IIT Kharagpur. Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6014	DIET AND NUTRITION	02

Program Outcomes addressed:

1. PO6 : The Engineer and The World
2. PO7: Ethics
3. PO11: Life-long learning

Course Objectives :

1. To provide students with a comprehensive understanding of nutrition principles and their application in promoting optimal health.
2. To develop critical thinking skills to evaluate nutritional information and make informed decisions.
3. To apply knowledge of nutrition education and counselling to promote healthy nutrition practices in individuals and group.
4. To demonstrate an understanding of role of nutrition in disease prevention and management.

Module	Details
01.	**Nutrition for wellness -1** Introduction to nutrition, food pyramid, Macros: Carbohydrates, Protein and fats, Micros: Vitamins A C E K and D, Minerals-Calcium, Iron and Zinc Importance of hydration, signs and symptoms, stages of dehydration.
02.	**Nutrition wellness -2** Introduction to mindful eating, plate concept, understanding physical and emotional hunger, eating disorder-Anorexia nervosa, bulimia nervosa and binge eating.
03.	**Exercise and fitness** Introduction to exercise and its importance, types of exercise its classification, side effects of over exercising, Impact of sedentary lifestyle on body composition.
04.	**Sleep and relaxation** Flow of circadian rhythm, sleep cycle, stages of sleep, sides effects, sleeping disorder-sleep apnea, insomnia, sleep hygiene routine and foods inducing sleep
05.	**Managing stress** Introduction to stress, causes, effects of stress, management of stress, foods and adaptogenic foods for stress management.
06.	**The lifestyle flow** Morning/ wake up rituals, meal flow i.e in which order to eat, post meal flow, bedtime rituals – how should your last hour of the day look like
Total no. of hours: **30**	

Course Outcomes :

1. Understand the fundamentals of nutrition and its role in promoting wellness.
2. Apply mindful eating practices to manage physical and emotional hunger.
3. Assess the importance of exercise and its impact on health and fitness
4. Gain insights into sleep hygiene and manage sleep-related disorders.
5. Develop strategies for stress management using nutrition and adaptogenic foods.

6. Assess the importance of exercise and its impact on health and fitness

Text Books :

1. Nutrition and dietetics by C.S. shah: covers various aspects of nutrition, including nutrient metabolism, dietary planning and diet therapy.
2. Dietetics by B. Srilakshmi- covers aspects of dietetics including nutrition, food science and diet therapy.

Reference Books :

1. Nutrition science by B. Shrilakshmi: provides an overview of nutrition, nutrient metabolism and dietary patterns
2. Food science by B. Shrilakshmi covers food, including food composition, food processing and food safety.

Course Type	Course Code	Course Name	Credits
LLC	LLC6015	PERSONALITY DEVELOPMENT	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-long learning

Course Objectives :

1. To enhance self-awareness and self-confidence in the students.
2. To develop effective communication, leadership, and interpersonal skills.
3. To equip students with stress management and time management techniques.
4. To foster teamwork, problem-solving, and decision-making abilities.
5. To prepare students for professional life through resume building, interview skills, and networking.
6. To instil a growth mindset and adaptability in personal and professional contexts.

Module	Details
01.	**Self-Awareness and Emotional Intelligence** Understanding personality traits and self-assessment, Importance of emotional intelligence (EI) in personal and professional success, Strategies to enhance EI and self-awareness.
02.	**Communication Skills** Fundamentals of verbal and non-verbal communication, Public speaking, presentation skills, and storytelling, Listening skills and constructive feedback.
03.	**Leadership and Teamwork** Understanding importance of self-confidence, leadership styles, and their applications, Building effective teams and managing conflicts, Developing collaboration and networking skills.
04.	**Stress and Time Management** Recognizing stressors and managing stress effectively, Prioritization and goal-setting techniques, Tools for efficient time management and productivity.
05.	**Professional Development** Importance of presentation skills, resume writing, cover letter, and LinkedIn optimization, Interview preparation: Mock interviews and common questions, Networking skills and professional etiquette
06.	**Personal Growth and Adaptability** Developing a growth mindset and embracing lifelong learning, Cultivating resilience and adaptability to change, Setting long-term personal and professional goals
Total no. of hours: **30**	

Course Outcomes : By the end of this course, students will be able to:

1. Demonstrate increased self-awareness and emotional intelligence.
2. Communicate effectively in professional and personal contexts.
3. Exhibit leadership and teamwork skills in various scenarios.
4. Manage time and stress efficiently to enhance productivity.
5. Prepare a professional resume, excel in interviews, and network effectively.
6. Develop resilience, adaptability, and a growth-oriented mind-set.

Text Books :

1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ / What Makes a Leader: Why Emotional Intelligence Matters
2. Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change

Reference Books :

1. Dale Carnegie, How to Win Friends and Influence People.
2. Anthony Robbins, Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical, and Financial Destiny!
3. David J. Schwartz, The Magic of Thinking Big.
4. Robin Sharma, The Monk who sold his Ferrari.
5. Dorie Clark, Reinventing You: Define Your Brand, Imagine Your Future.
6. Gangadhar Joshi, Campus to Corporate: Your Roadmap to Employability.

Other Resources

1. Videos and TED Talks by Simon Sinek, Brené Brown, Malcolm Gladwell and other motivational speakers
2. Online courses on communication and leadership (e.g., Coursera, LinkedIn Learning, EdX).