AC-01-Item No. 2.0, 2.4, 3.0 & 3.4 dated 29th April 2024
AC-04-Item No. 3.1.4 dated 7th March 2026

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.

&

Fourth Year B. Tech. Syllabus

Prepared by: Board of Studies for Electrical Engineering

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

Effective from: 2026-27

Revision: R-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, we strive to nurture engineers who not only excel in their fields but also contribute meaningfully to society.

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

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

4. **Opportunities for Teachers in Innovation:** We recognize the pivotal role of our faculty in shaping the educational experience. Our curriculum provides ample opportunities for teachers to innovate in teaching-learning methodologies and evaluation techniques. Through continuous 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 future of engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

Dean of Academics Agnel Charities Fr. C. Rodrigues Institute of Technology, Vashi

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.

Contents

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	Digital Business Management
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	Disaster Management and Mitigation Measures
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
Final Year

Course Type	Course Code	Course Name	Credits
PCC	EEPCC712	Electrical Systems Design And Auditing	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
4. EEPCC510 Protection and Switchgear

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
6. PO10: Project management and finance
7. PO11: Life-long learning

Course Objectives:

1. To comprehend various electrical systems, drawings and comprehend their application in electrical projects
2. To comprehend design of distribution substation and selection/sizing of cable and other auxiliary systems
3. To study data information analysis techniques and electrical load management techniques to apply in Energy audit project.
4. To familiarize with energy performance assessment of electrical system and different energy efficient technologies to use in energy audit process

Module	Details	Hrs.
	Course Introduction This course focused on design of electrical distribution network which is primarily required for HT consumer. It includes design of power distribution substation, selection sizing of various equipment used in the substation including distribution transformer, UG cable/Busbar, DG, interior lighting system etc. It also includes energy auditing of an existing electrical installation and improving energy efficiency by using different energy efficiency technologies such as Variable frequency drive, energy efficient motors etc.	**01**
01.	**Electrical Systems and Electrical Projects:**	**07**

	Learning Objective/s: *To impart the knowledge of different electrical projects and types of electrical drawings used in electrical projects, as well as to familiarize with different power distribution system and their selection criteria*	
	Contents: Types of electrical Projects, Types of electrical system, Activities of electrical engineer in Electrical projects, different plans/ drawings in electrical system design, single line diagram, Standard symbols to use in SLD. Three line diagram and its comparison with SLD. Different types of power distribution system and its selection criteria, Concept of RMU (Ring Main Units) in distribution systems, Difference between RMUs and HT Switchgears	
	Self-Learning Topics: *NA.* ***Learning Outcomes:*** *A learner will be able to* *LO1.1 Apply electrical engineering concepts to understand different electrical power distribution systems and electrical drawings and (P.I.-1.4.1)* *LO1.2 Apply knowledge of electrical engineering to differentiate different standard symbols to use in a single line diagram and illustrate its function towards the protection of the public (P.I.-1.4.1, 6.1.1)* *LO1.3 Apply fundamental engineering to understand the role of an electrical engineer in various electrical projects (P.I.-1.3.1)*	
02.	**Design of Power Distribution Substation:**	**09**
	Learning Objective/s: *To teach the requirements of a given electrical distribution system and deliver the process of designing distribution substation.*	
	Contents: Distribution Substation: Need, Advantages, Selection of site for substation, review of components in the substation. Selection of voltage rating of the installation, Factors to be considered for sizing of distribution transformer, Selection and sizing of distribution transformer and its specifications. Step and touch potential calculations for earthing grid design, Substation earthing design, TT, TN and IT systems. Review of different switchgears used in distribution network, Selection of HT/LT switchgears, metering, switchboards and MCC, Metering and protection CT and PTs, Time Current Characteristics of protection switchgear, Utilization category of switchgear, coordination and discrimination, Type 2 Coordination.	
	Self-Learning Topics: Special type Transformers, Protection against Electric shocks and electrical fires**.**	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply electrical engineering concepts to understand different parameters to consider for selection and sizing of distribution transformer. (P.I.- 1.4.1)* *LO2.2 Apply knowledge of fundamental engineering to calculate the specifications of protection equipment and auxiliaries required in distribution substation as per the applicable standards. (P.I.- 1.3.1,6.2.1)*	

	LO2.3 Determine design objectives, functional requirements while designing any distribution substation referring to regulations and standards relevant to distribution substation. (P.I.-3.1.6, 6.2.1) *LO2.4 Reframe given electrical power distribution network into simplified single line diagram. (P.I.-2.2.1)* *LO2.5 Explore and synthesize electrical engineering requirements considering safety issues while designing earthing system for any distribution substation (P.I.-3.1.5, 6.2.1)*	
03.	**Selection / Sizing of Cable and Auxiliary system:** ***Learning Objective/s:*** *To teach the design of feeder installations of a given electrical distribution system considering its requirements and make familiarize with other auxiliaries of a distribution network.* **Contents:** Cables used in a distribution network, Types of cable installation, Selection and sizing of cables, specification of cables, Concept of Earth / Unearth Cables, cable management systems, sizing of conduits and Trunking, Busbar system: advantages Comparison of bus bars with cables, sizing of busbars. Basics of selection of emergency/backup supplies, UPS, DG Set, Preliminary design of interior lighting system. IS standards applicable in above designs ***Self-Learning Topics:*** Construction details of a cable used in Distribution network ***Learning Outcomes:*** *A learner will be able to* *LO3.1Apply fundamental engineering knowledge to understand different cable installation methods and de-rating factors to consider refer to IEE wiring regulations while designing underground cables for the given electrical installations (P.I.- 1.3.1, 6.2.1)* *LO3.2 Apply electrical engineering concepts to calculate the size of underground cable for a given electrical installations and specify them as per standards. (P.I.- 1.4.1,6.2.1)* *LO3.3 Determine design objectives, functional requirements for selection and sizing of underground cable and arrive at its specifications referring to regulations and standards relevant to cable installations. (P.I.-3.1.6, 6.2.1)* *LO3.4 Explore and synthesize engineering requirements considering safety issues while designing any cable installation system or Busbar system (P.I.-3.1.5)* *LO3.5 Apply electrical engineering knowledge to understand different emergency supply systems. (P.I.-1.3.1)* *LO3.6 Determine design objectives, functional requirements for the design of interior lighting system. (P.I.- 3.1.6)*	**07**
04.	**Load Management in Electrical System:** ***Learning Objective/s:*** *To teach different commercial electricity bill parameters and impart the process to optimize the system demand by applying load management techniques.* **Contents:** Electricity billing of Industrial/commercial consumer, Impact of ToD tariff towards electrical load management, Power factor improvement and its benefit, sizing and location of capacitor banks, Impact of PF improvement on optimizing Electricity bill. Individual compensation of Motor load and Self-excitation phenomenon and its mitigation, effects of harmonics on PF Improvement system, Solution to mitigate the effect of harmonics.	**09**

	Self-Learning Topics: NA ***Learning Outcomes:*** *A learner will be able to* *LO4.1 Apply electrical engineering knowledge to understand different terms used to calculate commercial electricity bill and its role towards the load management. (P.I.-1.4.1,11.3.1)* *LO4.2 Apply the electrical engineering knowledge to analyze the effect of power factor tariff and TOD tariff towards optimizing maximum demand of the system. (P.I.-1.4.1, 11.3.2)* *LO4.3 Identify the electrical engineering knowledge that applies to decide the location of capacitor banks in the given electrical installations and understand the problems associated with the installations. (P.I.-2.1.2)* *LO4.4 Identify the electrical engineering knowledge that applies to mitigate different problems associated with power factor improvement installations. (P.I.- 2.1.3)*	
05.	**Energy Efficient Technologies :** ***Learning Objective/s:*** *To deliver the knowledge of different energy efficient technologies and analyze its effectiveness towards achieving energy efficiency of a given electrical installation.*	**07**
	Contents: Energy Efficient Motor: How to specify the motor, reasons for inefficiency, necessity of EEM, construction of EEM, classification of Motors based on their efficiency, Motor retrofit program, Technical aspects of EEM. Variable Frequency Drive: Application of VFD based on the load, comparison of VFD with conventional control, energy saving potential case study, effect of VFD on Motor. Energy Efficient Lighting Design (EELD): Lighting Power Density, Installed Load Efficacy Ratio (ILER), ILER assessment, Electronic Ballast, Lighting control techniques, energy saving potential case study. Soft starters, Energy Efficient pump, Maximum Demand controllers, Automatic Power Factor Controllers, Energy Efficient Transformer, BLDC Motor (EC Motor).	
	Self-Learning Topics: Energy Management system (EMS) and Building Management System (BMS).	
	Learning Outcomes: *A learner will be able to* *LO5.1 Apply electrical engineering knowledge to differentiate various energy efficient technologies. .(P.I.-1.4.1)* *LO5.2 Apply fundamental engineering concepts to calculate the energy saving potential of different energy efficient technologies. (P.I.- 1..1.1, 6.3.2)* *LO5.3 Analyze the effectiveness of different energy efficient technologies to apply in a given electrical installations, on a techno-economic basis for the sustainable development. (P.I.-2.2.3, 6.3.2, 10.2.1)* *LO5.4 Compare and contrast different energy efficient technologies to select the best on the basis of technical and economic feasibility. (P.I.- 2.2.4, 6.3.2, 10.2.1)*	
06.	**Energy Audit:** ***Learning Objective/s:*** *To equip the knowledge of an energy audit and its various approaches towards improving energy efficiency and analyze energy performance of a given electrical installation.*	**04**

	Contents: Energy Audit: Definition-need, Types of energy audit, Energy Management (audit) approach understanding energy costs, Bench marking, Maximizing system efficiencies, optimizing input energy requirement, fuel and energy substitution. Energy Audit instruments. Defining monitoring and targeting. Elements of monitoring and Targeting. Data Information Analysis techniques for energy optimization.	
	Self-Learning Topics: Features of Energy Conservation Act-2001	
	A learner will be able to, *LO5.1 Apply fundamental engineering knowledge to interpret energy audit process, its need and types to apply in the industry (P.I.-1.3.1, 11.1.1)* *LO5.2 Identify objectives of energy optimization in the plant and implement energy management techniques for the sustainable development (P.I.-2.1.1, 6.3.3, 11.1.1)* *LO5.3 Identify and select appropriate measuring instruments to conduct effectively energy audit in the plant. (P.I.-2.2.2)* *LO5.4 To apply fundamental engineering concept to understand energy monitoring and targeting and data information analysis techniques. (P.I.. 1.3.1)* *LO5.5 To use appropriate data information analysis techniques to analyze the recorded energy data to interpret the energy performance of given electrical installation. (P.I.. 4.3.1)* *LO5.6 Represent data in a graphical form to facilitate analysis of the data, and drawing of conclusions (P.I.- 4.3.3)*	
	Course Conclusion The course will conclude with the process and design of electrical distribution network which includes, distribution transformer, UG cable and associated metering and protection systems. It also concludes with the importance of energy audit to analyze the energy performance of an electrical distribution network and its improvement using different energy efficient technologies.	**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 Mechanical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.1	Articulate problem statements and identify objectives
2.1.3	Identify the mathematical, electrical engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub 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
2.2.4	Compare and contrast alternative solution processes to select the best process.
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
3.1.6	Determine design objectives, functional requirements and arrive at specifications
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions

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

6.3.3 Describe management techniques for sustainable development

10.2.1 Analyze and select the most appropriate proposal based on economic and financial considerations.

11.1.1 Describe the rationale for the requirement for continuing professional development

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

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

Course Outcomes :

1. Apply electrical engineering knowledge to select suitable power-distribution systems, interpret electrical drawings, and explain the role of an electrical engineer in project execution. *(LO1.1, 1.2, 1.3)*
2. Design an electrical distribution substation for a given installation and develop its single-line diagram in accordance with relevant standards. *(LO2.1, 2.2, 2.3, 2.4, 2.5)*
3. Design underground cable systems, busbar arrangements, and interior lighting systems for specified electrical installations in compliance with applicable safety standards. *(LO3.1, 3.2, 3.3, 3.4, 3.5, 3.6)*
4. Students will be able to analyze commercial electricity bills to optimize demand and propose solutions for improving power factor performance. *(LO4.1, 4.2, 4.3, 4.4)*
5. Analyze energy-efficient technologies and evaluate their techno-economic and environmental feasibility to improve the energy performance of electrical installations. *(LO5.1, 5.2, 5.3, 5.4)*
6. Identify and apply appropriate energy monitoring and data analysis techniques to evaluate the energy performance of industrial installations as part of the energy audit process. *(LO6.1, 6.2, 6.3, 6.4, 6.5, 6.6)*

CO-PO mapping table with correlation level:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
EEPCC712.1	3					3					
EEPCC712.2	3	2	3			3					
EEPCC712.3	3		3			3					
EEPCC712.4	3	3		3		3					3
EEPCC712.5	3	3				3				3	
EEPCC712.6		3	3			3					3
Average	**3**	**2.75**	**3**	**3**		**3**				**3**	**3**

Text Books :

1. Handbook of Electrical Installation Practice, Fourth Edition, by Geofry Stokes, Blackwell Science
2. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000
3. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
4. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
5. Energy Management Handbook, by W.C. Turner, John Wiley and sons
6. Handbook on Energy Audits and Management‖, by Amit Kumar Tyagi, TERI

7. General Aspects of Energy Management and Energy Audit, Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE
8. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press
9. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
10. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.

Reference Books:

1. Medium Voltage technical guide, Basics for MV design according to IEC and IEEE standards, by Schneider Electric
2. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010
3. Energy Auditing Made Simple‖, by P. Balasubramanian, Seperation Engineers (P) Ltd
4. Energy Management Principles, by C.B. Smith, Peragamon Press
5. Energy Efficiency in Electric Utilities Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE

Web References:

1. http://www.bee-india.nic.in/
2. NPTEL Video Course: NOC: Electrical Distribution System Analysis http://www.digimat.in/nptel/courses/video/108107112/L04.html

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. **Continuous Assessment (20 Marks)**
   - 01 MCQ test: 05 Marks
   - 01 Class test: 05 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%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PE	PEC7051	Power System Operation 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. PCC303- Elements of Power System
2. PCC408- Power System Engineering
3. PCC510- Protection and Switchgear

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5-Modern tool usage
4. PO6: The Engineer and The World
5. PO11: Life-long learning

Course Objectives:

1. To study load flow analysis and solve load flow problem using different numerical techniques.
2. To impart knowledge on generator operating cost, incremental cost, constraints in operation, solve load scheduling and unit commitment problem.
3. To study operation of power system using load frequency control and voltage control.
4. To impart knowledge on dynamics of synchronous generator, power system stability and its analysis.
5. To understand concept of interchange of power and energy.

Module	Details	Hrs
	Course Introduction **Power scenario in Indian grid, National and Regional load dispatching centers**. Power system operation and control is a specialized course in electrical engineering that deals with load flow analysis to ensure a continuous supply of power under steady state condition, economic operation of generators, stable operation by balancing power generation with demand, maintaining optimal voltage and frequency levels, ensuring the power exchange for efficient operation of the grid. Maintaining security and complying with industry standards are vital aspects of power system operation and control, ensuring the safe and secure delivery of electricity. Hence, the fundamental concepts of this course are essential for power system engineers.	**01**
01.	**Load Flow Studies**	**09-10**
	Learning Objective: *To teach load flow analysis and solve load flow problem using different numerical techniques and simulate using modern tools.*	
	Contents Introduction, formation of Y bus using direct method, step by step method, Load flow problem, Load flow equation and methods of solution, Gauss-Seidel method, Newton-	

	Raphson method, Decoupled load flow method, Fast decoupled load flow method, Comparison of load flow methods (Numerical)	
	Self-Learning Topics: *Identify modern engineering tools for modeling and analysis of load flow problems*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply advanced mathematical techniques to model and solve load flow problems problems (PI-1.1.2)* *LO1.2: Apply electrical engineering concepts to solve engineering problems using load flow methods (PI-1.4.1)* *LO1.3: Identify engineering systems, variables, and parameters to solve the load flow problems using numerical techniques (PI-2.1.2)* *LO1.4: Compare and contrast alternative solution processes to select the best process for solving the problem using numerical techniques (PI-2.2.4)* *LO1.5: Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources to solve engineering problems(PI-5.1.1, 5.1.2)*	
02.	**Economic Operation of Power System**	**06-07**
	Learning Objective: *To impart knowledge on generator operating cost, incremental cost, constraints in operation, solve load scheduling and unit commitment problem.*	
	Contents: Optimal operation of generators in thermal power station, heat rate curve, input-output curve, IFC curves, optimum generation scheduling neglecting Transmission losses (coordinate equation), optimum generation scheduling considering transmission losses (Exact coordinate equation), Transmission loss formula, Bmn coefficient, optimal unit commitment (Numerical)	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO2.1: Apply fundamental engineering concepts to solve optimum generation scheduling problems (PI-1.3.1)* *LO2.2: Apply Electrical engineering concepts to solve optimum generation scheduling problems (PI-1.4.1)* *LO2.3: Identify engineering systems, variables, and parameters to solve optimum generation scheduling problems, Understand the relationship between the technical, socio economic and environmental aspects of sustainability to solve for optimum generation scheduling (PI-2.1.2, 6.3.2)* *LO2.4:Identify the mathematical, engineering and other relevant knowledge to obtain transmission loss coefficient, Apply principles of preventive engineering and sustainable development for solving co-ordination equation (PI-2.1.3, 6.3.4)*	
03.	**Automatic Generation control**	**08-09**
	Learning Objective: *To impart knowledge on automatic generation control in power system using load frequency control*	
	Contents: Introduction, necessity of voltage and frequency regulation, Basic control loops in generator, Basics of speed governing mechanisms and modelling, thermal control, steam turbine, and power system transfer function, Load frequency control (single area), speed load characteristics, regulation of two generators in parallel. steady state and dynamic response, integration of economic dispatch control with LFC. Load frequency control of two area system, Composite block diagram (Numerical)	

	Learning Outcomes: *A learner will be able to* *LO3.1: Apply advanced mathematical techniques to model turbine speed governing system for thermal control (PI-1.2.1)* *LO3.2: Apply Electrical engineering concepts to solve load frequency control problems. (PI-1.4.1)* *LO3.3: Identify engineering systems, variables, and parameters to solve the problems of steady state and dynamic response of load frequency control of an isolated power system, Interpret codes, and standards relevant to load frequency and voltage control (PI- 2.1.2, 6.2.1)* *LO3.4: Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions to solve load frequency control problems, using principles of preventive engineering (PI-2.2.3, 6.3.4)*	
04.	**Power System Stability**	**09-10**
	Learning Objective: *To teach out of step falling of synchronous generator, different techniques for power system stability analysis using equal area criterion*	
	Contents: Introduction to stability, types of stability, Power angle curve, dynamics of synchronous machine, Swing equation, steady state stability, transient stability, analysing transient stability using the equal area criterion, some techniques for improving transient stability (Numerical)	
	Self-Learning Topics: *Identify modern engineering tools for modeling and analysis of stability*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply advanced mathematical techniques to model and solve problems on stability in power system (PI- 1.1.2)* *LO4.2: Apply Electrical engineering concepts to solve numerical on steady state stability problems. (PI-1.4.1)* *LO4.3: Identify engineering systems, variables, and parameters to solve the problems using swing equation for transient stability, Interpret codes, and standards relevant to stability (PI-2.1.2, 6.2.1)* *LO4.4: Identify existing processes/solution methods for solving the problem of transient stability, Apply principles of preventive engineering for stability of system (PI-2.2.3, 6.3.4)* *LO4.5: Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources to solve engineering problems (PI-5.1.1, 5.1.2)*	
05.	**Voltage Stability**	**07-08**
	Learning Objective: *To impart knowledge on the concepts of voltage stability using reactive power control.*	
	Contents: Introduction, Comparison of Angle and Voltage Stability, Reactive Power Flow and Voltage Collapse, Mathematical Formulation of Voltage Stability, Voltage Stability Analysis, Prevention of Voltage Collapse, Future Trends and Challenges.	
	Learning Outcomes: *A learner will be able to* *LO5.1: Apply advanced mathematical techniques to model and solve problems on voltage stability in power system (PI- 1.1.2)* *LO5.2: Apply Electrical engineering concepts to solve numerical on voltage stability problems. (PI-1.4.1)* *LO5.3: Identify engineering systems, variables, and parameters to solve the on voltage stability, Interpret codes, and standards relevant to stability (PI-2.1.2, 6.2.1)*	

	LO5.4: Identify existing processes/solution methods for solving the problem of voltage stability, Apply principles of preventive engineering for stability of system (PI-2.2.3, 6.3.4)	
06.	**Power system security and Interchange of power**	**04-05**
	Learning Objective/s: *To impart knowledge on interchange of power and energy between utilities*	
	Contents: **Power system security**: System state classification, security analysis, contingency analysis. **Interchange of power**: Interchange of power between interconnected utilities, types of interchange, capacity and diversity interchange, energy banking, power pools	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify engineering systems, variables, and parameters for security analysis and contingency analysis, Identify impacts of power and energy interchange activity for sustainable development (PI-2.1.2, 6.3.3)* *LO 6.2: Compare and contrast alternative solution processes to select the best process, Understand the relationship between the technical, socio economic and environmental dimensions of sustainability using security analysis and contingency analysis in power system (PI-2.2.4, 6.3.4)* *LO6.3: Recognize the need and keep current regarding new developments in power interchange schemes (PI-11.2.1, 11.2.2)*	
	Course Conclusion It involves the continuous, coordinated management of power generation and load to deliver electricity to consumers with uninterrupted supply, stable frequency, and acceptable voltage. This is achieved through real-time monitoring, automatic control systems like Load Frequency Control (LFC) and Automatic Voltage Regulators (AVR), and economic dispatch to balance generation with dynamic demand while minimizing costs and ensuring system reliability.	**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.
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
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
6.2.1	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
6.3.3	Describe management techniques for sustainability
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. Analyze load flow problems in power system using different numerical techniques *(LO1.1, LO1.2, LO1.3, LO1.4).*
2. Apply and analyze load scheduling and unit commitment problem for sustainable development. *(LO2.1, LO2.2, LO2.3, LO2.4)*
3. Analyze automatic generation control using load frequency control (*LO3.1, LO3.2, LO3.3, LO3.4)*
4. Identify and analyze power system stability and voltage stability *(LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4)*
5. Discuss the concept of interchange of power and energy between utilities *(LO6.1, LO6.2).*

CO-PO mapping table with correlation level:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
EEPEC7031.1	3	3			3						
EEPEC7031.2	3	3				3					
EEPEC7031.3	3	3				3					
EEPEC7031.4	3	3			3	3					
EEPEC7031.5		3				3					3
Average	**3**	**3**			**3**	**3**					**3**

Text Books :

1. Kothari D.P., Nagrath I.J., Modern power system Analysis, TMH publication, 4e, 2019.
2. Chakrabarti A, Halder S., Power System Analysis-Operation and Control, PHI
3. Allen Wood, Bruce F. Wollenberg, Power Generation operation and control, Willey India
4. B.R. Gupta, Power System Analysis and Design, S. Chand

Reference Books :

1. Hadi Saadat, Power System Analysis, TMH publications, 2e
2. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Ltd, New Delhi, 30th reprint,2007.
3. Soman S.A., Kharpade S.A., and Subha Pandit - Computer Methods for Large Power System Analysis, an object Oriented Approach, Kluwer Academic Publisher New York 2001.

Other Resources :

1. NPTEL Course: Power System Analysis, Prof. A.K. Sinha, IIT Kharagpur
2. NPTEL Course: Power System Engineering, By Prof. Debapriya Das, IIT Kharagpur
3. NPTEL Course: Power System Protection, By Prof. Ashok Kumar Pradhan, IIT Kharagpur

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Numerical Assignment/s (min 20 problems): 05 Marks
   - Class test based on above numerical assignment: 05 marks
   - Technical report writing: 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	EEPEC7032	Digital VLSI 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. ECMDM3013: Electronic Components and Circuits

Program Outcomes addressed:

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

Course Objectives:

1. To impart fundamental knowledge of MOSFET behaviour and its application in VLSI circuits.
2. To evaluate the performance metrics of CMOS inverters and basic gates such as NAND and NOR.
3. To design combinational and sequential circuits using various design styles and implement them through HDL coding for verification and testing.
4. To analyse the structure and operation of RAM and ROM arrays.

Module	Details	Hrs
	Course Introduction Digital VLSI Design is a specialized course focusing on the design and implementation of high-performance integrated circuits. Understanding MOSFET operation, CMOS logic behavior, and the construction of combinational and sequential circuits is crucial for creating efficient and reliable digital systems. The course also emphasizes Hardware Description Languages (HDL) for modeling, simulation, and verification of complex logic designs. The fundamental concepts of this course are essential for designing, implementing, and testing modern VLSI circuits.	**01**
01.	**Fundamentals of VLSI and MOS Devices**	**04-05**
	Learning Objective/s: *To impart knowledge of MOSFET operation and characteristics relevant to VLSI design*	
	Contents Role and scope of VLSI in modern electronics, Overview of VLSI Design Flow, Metal Oxide Semiconductor Structure, MOS under External Bias, Operation of MOS Transistor. Threshold voltage equation and energy band diagram of MOSFET, controlling of threshold voltage. MOSFET current-voltage characteristics, mathematical models.	
	Learning Outcomes: *A learner will be able to*	

	LO 1.1: Apply fundamental engineering concepts to understand the role and scope of VLSI in modern electronics and outline the complete VLSI design flow. (P.I.–1.3.1) *LO 1.2: Apply principles of semiconductor physics to comprehend the metal–oxide–semiconductor structure and analyze its behavior under external bias. (P.I.–1.4.1)* *LO 1.3: Identify suitable methods to derive current–voltage characteristics of MOSFET for circuit analysis (P.I.–2.2.3)* *LO 1.4: Develop the threshold-voltage equation and energy-band diagrams by combining semiconductor physics and engineering approximations. (PI 2.3.1)*	
02.	**Static CMOS Logic Design**	**09-10**
	Learning Objective: *To analyze and design CMOS inverters, NAND, NOR, and complex logic circuits with respect to various performance metrics.*	
	Contents: CMOS inverter: operation, static and dynamic characteristics, Noise margins, power–speed–robustness trade-offs, Design and analysis of basic gates: NAND, NOR, XOR, Sizing of transistors for logic gates, Simple combinational design examples using static CMOS.	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply advanced mathematical techniques to model a CMOS inverter and determine its static and dynamic characteristics. (P.I.-1.1.2)* *LO 2.2: Apply fundamental engineering concepts to identify the operation of CMOS Inverter, NAND and NOR gate (P.I.-1.3.1)* *LO 2.3: Identify basic concepts of CMOS Inverter and analyze all the basic performance metrics of VLSI design (Noise margin, Propagation delay, Power dissipation and Area.in static and dynamic state (P.I.- 2.1.3)* *LO 2.4: Identify and utilize relevant parameters to choose a proper transistor sizing for reliable CMOS logic gate operation. (PI-2.1.2)*	
03.	**Alternative Logic Styles & Combinational Circuits**	**05-06**
	Learning Objective: *To design, implement and verify combinational logic circuits using various MOS design styles.*	
	Contents: Motivation for alternatives to static CMOS, Pseudo-nMOS, complementary pass-transistor logic, Dynamic, Domino, and Zipper logic concepts, Design of common combinational blocks: Multiplexers, encoders/decoders, Full adder, ripple-carry adder, carry-look ahead adder, Simple array multiplier.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify key parameters, trade-offs, and performance considerations for different logic styles and combinational circuits (P.I-2.1.2)* *LO 3.2: Analyze the basic concepts of different design styles for combinational circuits leading to conclusions in terms of merits and limitations. (P.I-2.4.4)* *LO 3.3: Determine the design objectives and set specifications for the combinational circuit design. (P.I.-3.1.6)* *LO 3.4: Identify suitable criteria for evaluation of alternate design solutions using different styles for applications of digital design such as full adder, Decoder etc..(P.I-3.2.3)*	

	LO 3.5: Develop the ability to analyze alternative CMOS logic styles, design combinational circuits, and effectively present solutions in collaborative activities. (P.I.- 3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.2.1, PI 9.2.2)	
04.	**Sequential Circuits and Timing**	**06-07**
	Learning Objective: *To design, implement and verify sequential logic circuits with timing analysis.*	
	Contents: Latches and flip-flops: SR, D, JK, master-slave configurations, Edge-triggered design and setup/hold time concepts, Meta stability and clock skew basics, CMOS implementation styles for sequential elements, Simple finite state machine (FSM) design examples.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Identify key characteristics and design variables for sequential circuit analysis. (P.I-2.1.2)* *LO 4.2: Combine semiconductor physics and CMOS concepts to model latches, flip-flops, and simple FSMs for analyzing their static and dynamic behavior. (P.I-2.3.1)* *LO 4.3: Determine the design objectives and establish specifications for the design of sequential circuits. (P.I.-3.1.6)* *LO 4.4: Apply structured idea-generation techniques to create multiple alternative design solutions for sequential logic circuits. (P.I.- 3.2.1)* *LO 4.5: Develop the ability to analyze and design CMOS-based sequential circuits, including latches, flip-flops, and simple FSMs, and effectively present solutions in team settings. (P.I.- 3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.2.1, PI 9.2.2)*	
05.	**On-Chip Memory**	**05-06**
	Learning Objective: *To analyze the working of NAND and NOR based ROM array.*	
	Contents: ROM array-NAND and NOR based ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM, Peripheral Circuits, Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory.	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply core principles of engineering to classify semiconductor memories. (P.I-1.4.1)* *LO 5.2: Apply fundamental engineering concepts to solve the problems of volatile memories. (P.I-1.3.1)* *LO 5.3: Identify the mathematical approach that applies to NAND and NOR flash memory. (P.I-2.1.3)* *LO 5.4: Extract the understanding objectives and limitations of 6T SRAM / 3T DRAM (P.I-2.4.4)*	
06.	**HDL Modeling and Simulation for Digital Circuits**	**09-10**
	Learning Objective/s: *To develop HDL code to model and test combinational and sequential circuits..*	
	Contents:	

	Verilog/VHDL basics: syntax, modules, ports, signals, Data types, operators, and procedural statements, Combinational Circuit Modeling: Implement AND, OR, XOR, multiplexers, decoders, Sequential Circuit Modeling: Implement D, JK, SR, and master-slave flip-flops, Simulation and Verification: Run testbenches to verify functionality.	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify the relevant HDL constructs, data types, operators, and engineering knowledge required to model the given combinational and sequential circuits. (P.I-2.1.3).* *LO 6.2: Compare alternative HDL coding styles and select appropriate modeling methods for a given design problem. (P.I.–2.2.4, P.I.–5.1.1).* *LO 6.3: Identify and correct syntax or functional errors in HDL code using simulation tools and waveform analysis. (P.I.–2.4.3, P.I.–5.1.2).*	
	Course Conclusion The course concludes with a comprehensive understanding of MOSFET operation, CMOS logic design, and the implementation of combinational and sequential circuits using various design methodologies. Additionally, the integration of Hardware Description Languages (HDL) for modeling, simulation, and verification enables learners to design and test complex digital systems for real-world VLSI applications.	**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.
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.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
3.2.3	Identify suitable criteria for evaluation of alternate 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
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non technical audiences

Course Outcomes: Learner will be able to

1. Comprehend MOSFET operation and characteristics within the context of VLSI design. *(LO 1.1, LO 1.2, LO1.3, LO1.4)*
2. Analyze and design basic CMOS circuits such as Inverters, NAND, and NOR gates, considering their performance and layouts. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Analyze and design CMOS combinational and sequential circuits, using various design styles, including timing behavior. (*LO 3.1, LO 3.2, LO3.3, LO3.4, LO 3.5, LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5)*
4. Analyze the performance and limitations of semiconductor memories used in VLSI design. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Develop HDL codes for combinational and sequential circuits with test bench and perform functional simulation using computer aided design tools. *(LO6.1, LO6.2, LO6.3)*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7032.1	3	3									
EEPEC7032.2	3	3									
EEPEC7032.3		3	3					3	3		
EEPEC7032.4	3	3									
EEPEC7032.5		3			3						
Average	**3**	**3**	**3**		**3**			**3**	**3**		

Text Books :

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2012
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.
3. Neil H.E Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design-A Circuits and Systems Perspective", 3 rd Edn, Pearson, 2009
4. Dr. S. Ramachandran, "Digital VLSI Systems Design", Springer, 2007.

Reference Books :

1. M. Morris Mano , "Digital Design", 3rd edition
2. N H E Weste & K, "Principles of CMOS VLSI design"
3. Wayne Wolf, "Modern VLSI Design: System on Silicon"
4. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, Student Edition, 2013.
5. Mead & Convey, "Introduction to VLSI Design",BS Publications, 2010.

Other Resources :

1. NPTEL Course: VLSI Design Verification and Test, By Dr.Santosh Biswas, Prof. Jatindra Deka, IIT Guwahati. Web link- https://nptel.ac.in/courses/106103016

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Simulations – 05 Marks
   - Class test: 05 marks
   - Activity based study-Team-Pair-Solo : 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	EEPEC7033	Automation and Control	03

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

Pre-requisite :

1. EEPCC406: Control System
2. EELBC404: Control System Laboratory
3. EEPCC509: Electrical Machines
4. EELBC507: Electrical Machines Laboratory
5. EESBL603: Industrial Automation Laboratory

Program Outcomes addressed :

1. PO1: Engineering Knowledge.
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer and The World
7. PO8: Individual and Collaborative Team Work
8. PO9: Communication
9. PO10: Project Management and Finance
10. PO11: Life Long Learning

Course Objectives :

1. To introduce basic principles of automation in production systems.
2. To explore production economics, costs, and investment analysis.
3. To comprehend automated flow lines and material handling systems.
4. To understand automated assembly systems and their components.
5. To impart knowledge on PLC architecture and programming methods.
6. To learn SCADA, DCS, HMI, and industrial communication protocols.

Module	Details	Hrs.
	Course Introduction This course offers a comprehensive overview of **automation and control systems** in modern manufacturing, focusing on key areas such as **automation strategies**, **production economics**, and **system design**. It covers essential topics like **automated flow lines**, **material handling**, and **assembly systems**, along with in-depth study of **control systems** including **PLCs**, **SCADA**, and **DCS**. Students will learn **PLC programming**, use of **timers, counters, PID controllers**, and gain exposure to **industrial communication protocols** like **PROFIBUS** and **HART**. The course also emphasizes the role of **HMIs** in system	**01**

	visualization and control, providing the skills needed to design, control, and optimize intelligent automated production systems.	
01.	**Basics Concepts of Automation** ***Learning Objective: To impart knowledge on automation principles and levels in production systems and analyze production economics through cost, investment, and efficiency evaluation.***	**4-6**
	Contents: Automation in Production System, Principles and Strategies of Automation, Review of elements of an Automated System and Levels of Automations, Advanced Automation Functions. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process.	
	Self-Learning Topics: Break Even Analysis	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to perform economic assessment of production automation. (PI-1.1.1)* *LO 1.2: Apply fundamental concepts of Automation and its levels to solve engineering problems. (PI-1.3.1)* *LO 1.3: Identify and define economic parameters affecting manufacturing systems. (I-2.1.2)* *LO 1.4: Identify the mathematical and other relevant knowledge to perform economic evaluation and analysis of automation in production systems. (PI-2.1.3)*	
02.	**Automated Production Lines** ***Learning Objective: To comprehend and analyze automated flow lines, transport mechanisms, buffer storage, and control functions for efficient machining automation and system design.***	**06-08**
	Contents: Automated Flow lines, Methods of Work-part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.	
	Self-Learning Topics: Case study on computer simulation of automated flow line	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply mathematical and engineering fundamentals to model cycle time, throughput, and buffer behavior in automated flow lines. (PI-1.1.1)* *LO 2.2: Apply fundamental engineering knowledge to understand work-part transport, transfer mechanisms, and automated machining systems. (PI-1.3.1)* *LO 2.3: Identify and formulate problems related to bottlenecks, blocking, starvation, and WIP in automated production systems. (PI-2.3.2)* *LO 2.4: Analyze flow lines with/without storage using models and simulations to draw valid performance conclusions. (PI-2.4.4)* *LO 2.5: Identify and use modern tools such as CAD, CNC simulators, and production line simulation software to model automated systems. (PI-5.1.1)* *LO 2.6: Validate and interpret results from computer simulation of automated flow lines, considering tool assumptions and limitations. (PI-5.3.2)*	
03.	**Material handling and Identification Technologies**	**05-07**
	***Learning Objective:** To understand and analyze automated flow-line systems—including work-part transport methods, transfer mechanisms, buffer storage, and machining automation—and evaluate their performance using analytical models and computer simulation to recommend effective design and optimization solutions.*	

	Contents: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc. **Automated Assembly Systems:** Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multistation Assembly Machines, Analysis of a Single Station Assembly Machine.	
	Self-Learning Topics: Case Studies of Automated Manufacturing Lines	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply mathematical, engineering, and manufacturing fundamentals to model and design production systems, flow lines, material handling systems, and automated assembly/machining systems. (PIs-1.1.1, 1.3.1, 2.1.2, 2.3.1)* *LO 3.2: Identify, formulate, and analyze bottlenecks, WIP, storage, material flow, and assembly cycle issues using analytical and simulation-based methods to draw valid conclusions. (PIs-2.1.3, 2.4.2, 4.3.2, 4.3.4)* *LO 3.3: Design and refine material handling, storage, and automated assembly systems—including conveyors, AGVs, AS/RS, part-feeding systems, and multi-station layouts. (PIs-3.2.3, 3.3.1)* *LO 3.4: Use modern tools to model, simulate, and validate flow lines, material handling systems, AS/RS, AGVs, and assembly machines while considering tool limitations and assumptions. (PIs-5.1.1, 5.3.2)* *LO 3.5: Evaluate automated material handling and assembly systems in terms of safety, ergonomics, sustainability, environmental, social, and economic impact. (PIs-6.1.1, 6.3.2)* *LO 3.6-Work effectively in diverse teams to analyze, design, integrate, and communicate solutions for conveyors, AGVs, AS/RS, automated assembly systems, and identification technologies (RFID, barcode). (PIs-8.2.1, 8.3.1, 9.1.2, 9.2.2, 10.3.1, 10.3.2)*	
04.	**Introduction to Programmable Logic Controllers** ***Learning Objectives:*** *To impart knowledge on the structure, working principles, programming methods, and data handling of PLCs—including I/O processing, tasks, function blocks, and communication interfaces—and apply this knowledge to compare relay vs. PLC logic and select an appropriate PLC controller for industrial applications.*	**09-11**
	Contents: Basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study) Centralized concept. (SLE: types of field bus systems)	
	Self-Learning Topics: Fieldbus communication systems used in industrial PLC networks.	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Apply mathematical, scientific, and engineering fundamentals to understand and explain PLC definitions, structure, working principles, firmware/software concepts, data storage, and interpretation of PLC I/O flags, variable types, and structured data used in industrial automation. (PIs - 1.1.1, 1.3.1)*	

	LO 4.2: Identify, formulate, and analyze automation problems by evaluating PLC tasks, configurations, PID behaviour, and comparing relay logic with PLC logic through case studies to arrive at justified conclusions. (PIs - 2.1.1, 2.4.1) *LO 4.3: Design PLC-based automation solutions using function blocks, operators, arrays, data structures, and structured programming methods (LD, ST, FBD, SFC) to generate and document reliable industrial control programs. (PIs - 3.1.1, 3.3.1)* *LO 4.4: Use and evaluate modern engineering tools including PLC programming software, firmware utilities, monitoring tools, PC–PLC interfacing systems, and industrial communication technologies such as Fieldbus to design, test, and validate PLC automation. (PIs - 5.1.1, 5.3.1)* *LO 4.5: Communicate PLC-related technical information by documenting PLC architecture, programming methods, I/O processing, and presenting PLC selection and program results effectively in written and oral formats. (PIs - 9.1.1, 9.3.1)* *LO 4.6: Demonstrate life-long learning skills by exploring new PLC technologies, modern Fieldbus systems, evolving communication protocols, and emerging industrial automation practices to stay updated with technological advancements. (PIs - 11.1.1, 11.3.1)*	
05.	**Applications of PLC with HMI** ***Learning Objective/s: To understand and apply PLC ladder logic operations—including logic functions, rung analysis, timers, counters, data handling, sequencers, and visualization systems—to design basic automation tasks. They will also be able to interface HMI/PC-based controllers with PLCs and develop simple HMI screens for monitoring and control.***	**04-06**
	Contents: Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI's, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation).	
	Self-Learning Topics: *Applications of HMI's, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation)*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply engineering and logical fundamentals to understand conventional ladder vs. PLC ladder diagrams, basic logic operations (AND, OR, NOT, XOR), series–parallel logic functions, and analysis of PLC rungs for industrial control applications. (PIs - 1.1.1, 1.3.1)* *LO 5.2: Identify and analyze automation problems by evaluating timer and counter instructions (ON-delay, OFF-delay, retentive types, up/down counters), combining counters with timers, and using comparison and data-handling instructions to diagnose control requirements and limitations. (PIs - 2.1.1, 2.4.1)* *Lo 5.3: Design PLC-based solutions using sequencer instructions, visualization systems, PC-based controller concepts, and structured ladder logic to create reliable HMI-based automation processes and implement control sequences for industrial systems. (PIs - 3.1.1, 3.3.1)* *Lo 5.4: Use modern engineering tools including HMI software, visualization platforms, PLC programming tools, and controller–HMI interfacing techniques to configure, test, and validate industrial automation systems (SLE: programming and implementation of HMI). (PIs - 5.1.1, 5.3.1)* *LO 5.5: Communicate automation-related technical information by documenting ladder logic analysis, timer/counter operations, sequencer design, HMI configuration techniques, and presenting control process outcomes through visual interfaces. (PIs - 9.1.1, 9.3.1)* *LO 5.6: Demonstrate life-long learning skills by exploring emerging visualization systems, modern HMI programming practices, advanced PC-based controller technologies, and continuously updating skills in industrial automation environments. (PIs - 11.1.1, 11.3.1)*	
06.	**Supervisory control & data Acquisitions**	**09-11**
	Learning Objective/s: *To impart knowledge on the architecture and communication principles of SCADA and DCS, including industrial networks and BUS/Fieldbus protocols such as GPIB, HART, OLE, FIP, PROFIBUS, and Bit-bus, interface SCADA with controllers, perform basic SCADA programming, and implement PC-based monitoring and control through case-study-based applications.*	

	Contents: Introduction to Supervisory Control & Data Acquisition (SCADA), Distributed Control System (DCS): computer networks and communication in DCS. OSI (Open Systems Interconnection) framework and its role in industrial communication architecture. Different BUS configurations used for industrial automation – GPIB, HART and OLE protocol. Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process Field Bus), Bit bus. OPC UA (Open Platform Communications Unified Architecture) protocol for secure, platform-independent industrial data exchange and interoperability. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC-based Controller / HMI, (SLE: Case study & implementation for different examples.) **Industry 4.0 Concepts:** Introduction to Industry 4.0 architecture and smart manufacturing. Cyber Physical Systems (CPS), Industrial Internet of Things (IIoT), Cloud Computing and Edge Computing in industrial automation, Digital Twin technology, Big Data Analytics and Predictive Maintenance in automated production systems. Role of SCADA and DCS in smart factory integration and real-time data-driven decision making.	
	Self-Learning Topics: *Case study on SCADA implementation for any industrial process (e.g., water tank, boiler, conveyor).*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply engineering fundamentals to understand Supervisory Control and Data Acquisition (SCADA) systems, Distributed Control Systems (DCS), industrial communication networks, and BUS configurations such as GPIB, HART, OLE, FIP, PROFIBUS, and Bit-bus used in industrial automation. (PIs - 1.1.1, 1.3.1)* *LO 6.2: Identify and analyze automation and communication problems by evaluating the behaviour, limitations, and performance of DCS networking, Fieldbus protocols, and controller–SCADA communication issues in real industrial environments. (PIs - 2.1.1, 2.4.1)* *LO 6.3: Design automation solutions by integrating SCADA with PLCs and controllers, developing basic SCADA programs, configuring DCS nodes, and creating effective monitoring & control architectures using industrial communication protocols. (PIs - 3.1.1, 3.3.1)* *LO 6.4: Use modern engineering tools including SCADA development software, DCS engineering tools, Fieldbus configuration utilities, and PC-based HMI systems to implement, test, and validate industrial automation communication networks. (PIs - 5.1.1, 5.3.1)* *LO 6.5: Communicate technical information by documenting SCADA programming steps, DCS configurations, Fieldbus network layouts, and presenting monitoring/control strategies using graphical SCADA and HMI interfaces. (PIs - 9.1.1, 9.3.1)* *LO 6.6: Demonstrate life-long learning by exploring evolving industrial communication technologies, modern Fieldbus standards, SCADA advancements, and real-world case studies (SLE) to stay updated with automation industry trends. (PIs - 11.1.1, 11.3.1)*	
	Course Conclusion This course serves as a comprehensive gateway into the world of **industrial automation and control**, empowering students with the knowledge and skills necessary to excel in advanced manufacturing environments. By covering everything from **automation principles**, **economic analysis**, and **automated system design** to **PLC programming**, **control logic**, and **industrial networking**, students are equipped to take on real-world automation challenges. Through an integrated study of **control systems**—including **PID controllers**, **timers and counters**, **HMI-SCADA integration**, and **communication**	**01**

	protocols—the course ensures that learners can implement reliable and intelligent control strategies for diverse production operations. By the end of this course, students will not only understand how to **design and analyze automated systems**, but also how to **control**, **monitor**, and **optimize** them effectively using modern tools and technologies. This positions them to contribute meaningfully to the realization of **smart factories** and the advancement of **Industry 4.0** goals.	
	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.
2.1.1	Articulate problem statements and identify objectives.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems .
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.1	Recognize that need analysis is key to good problem definition.
3.2.3	Identify suitable criteria for the evaluation of alternate design solutions.
3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development.
4.3.2	Analyze data for trends and correlations, stating possible errors and limitations.
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.3.1	Discuss limitations and validate tools, techniques and resources.
5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and non-technical information.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
9.2.2	Deliver effective oral presentations to technical and non-technical audiences.
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations.

10.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.

10.3.2 Use project management tools to schedule an engineering project, so it is completed on time and on budget.

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

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

Course Outcomes: A learner will be able to -

1. Apply mathematical tools and automation concepts to identify economic factors and perform economic evaluation of production automation systems. *(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyze automated flow lines, identify production issues, and use modern simulation tools to evaluate and validate system performance. (*LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6)*
3. Analyze automated production and material handling systems, use modern tools for simulation and evaluation, and work effectively in teams to develop integrated automation solutions. (*LO3.1, L3.2, LO3.3, LO3.4, LO3.5, LO3.6)*
4. Analyze and design PLC-based automation systems using modern tools, communicate results effectively, and stay updated with evolving industrial automation technologies. (*LO4.1, L4.2, LO4.3, LO4.4, LO4.5, LO4.6)*
5. Analyze PLC-HMI automation systems, use modern tools to validate control processes, communicate results, and stay updated with emerging automation technologies. (*LO5.1, L5.2, LO5.3, LO5.4, LO5.5, LO5.6)*
6. Analyze, design, and implement SCADA, DCS, and industrial communication networks using modern tools, communicate technical solutions effectively, and continuously update their skills in evolving automation technologies. (*LO6.1, L6.2, LO6.3, LO6.4, LO6.5, LO6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7033.1	3	3									
EEPEC7033.2	3	3			3						
EEPEC7033.3	3	3	3	3	3	3		3	3	3	
EEPEC7033.4	3	3	3		3				3		3
EEPEC7033.5	3	3	3		3				3		3
EEPEC7033.6	3	3	3		3				3		3
Average	3	3	3	3	3	3		3	3	3	3

Text Books :

1. "Automation, Production Systems and Computer Integrated Manufacturing", M.P. Grover, Pearson Education, 2015/2016.
2. "Principles and Applications of PLC", Webb John, McMillan 1992.
3. "Process Control Instrumentation Technology", Johnson Curties, Prentice hall of India, 8th edition.
4. "Programmable Logic Controllers" by W. Bolton.

Reference Books :

1. "Computer Based Industrial Control", Krishna Kant, EEE-PHI.
2. "An Introduction to Automated Process Planning Systems", Tiess Chiu Chang & Richard, A. Wysk, Prentice Hall, 1985.
3. "Anatomy of Automation", Amber G.H & P.S. Amber, Prentice Hall.
4. "Introduction to Programmable Logic Controllers", Garry Dunning, Delmar Publishers, 2nd edition.
5. "Instrumentation Engineers Hand Book - Process Control", Bela G Liptak, Chilton book company, Pennsylvania.
6. "Programmable Logic Controllers", Hugh Jack.

Other Resources :

NPTEL Course 1: https://onlinecourses.nptel.ac.in/noc21_me67/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Case Study assignment: 10 Marks
   - Think-Pair-Share/Mind Mapping/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	EEPEC7041	Smart Power System	3

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

Pre-requisite:

1. Electrical Power System
2. Renewable Energy and Energy Storage

Program Outcomes addressed:

1. PO 1: Engineering Knowledge
2. PO 2: Problem Analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 6: The Engineer and The World
6. PO 11: Life-long learning

Course Objectives:

1. To illustrate the architecture and functional aspects of Smart Power Systems and Smart Grids.
2. To classify and summarise functions of modern sensing, communication, and data management technologies in grid operations.
3. To differentiate basic control strategies required to integration of renewable energy sources and energy storage systems.
4. To interpret the functional requirements and summarize the operational impact of intelligent automation, protection, and control schemes used in smart power networks.
5. To familiarize with cybersecurity, standards, and policy frameworks in smart grids.
6. To illustrate the practical application of advanced Smart Grid technologies by interpreting successful global or national deployment case studies.

Module	Details	Hrs.
	Course Introduction The evolution of conventional power systems into intelligent, adaptive, and sustainable networks has transformed the landscape of modern electrical energy. Smart Power Systems integrate advanced sensing, communication, and control technologies to optimize the generation, transmission, and distribution of electricity. This course explores the architecture, functional elements, and communication frameworks that enable real-time monitoring, automation, and efficient power flow management. With special emphasis on integration of	**1**

	distributed energy resources, renewable generation, and energy storage, supported by advanced metering and grid management technologies. Through a systematic study of these components, the course provides a comprehensive foundation for understanding the design, operation, and performance of contemporary power networks, highlighting the principles that ensure reliability, efficiency, and sustainability.	
01.	**Evolution of Power System** ***Learning Objective:*** *Illustration of evolution of power systems and distinguish modern smart grids, smart power systems, and microgrids along with key drivers and emerging trends.* **Contents:** Historical development of power systems; Drivers for power system transformation; Transition from conventional to modern grids; Characteristics of Smart Power Systems; Emerging trends in modern power systems; Difference between Smart Grid, Smart Power System & Microgrid ***Self-Learning Topics:*** *Global evolution journey, Key Indian initiatives: RDSS, SAUBHAGYA, Green Energy Corridors.* ***Learning Outcomes:*** *A learner will be able to* *LO1.1* *Apply fundamental engineering concepts to understand and apply principles of sustainable development to understand why modern grids prioritize efficiency, resilience, carbon reduction, and distributed energy resources. (PI 1.3.1, PI 6.3.4)* *LO1.2* *Utilize specialized electrical engineering knowledge to interpret the functioning and transformation of components within smart grids, microgrids, and modern power systems. (PI 1.4.1)* *LO1.3* *Identify and analyze the evolution of power systems terms of socio-economic, environmental, and sustainability as key drivers, challenges, and objectives behind the transition from conventional power systems to modern smart grids by articulating clear problem statements. (PI 2.1.1, PI 6.3.2)* *LO1.4* *Recognize and connect the relevant engineering principles to stay updated with emerging technologies—such as system stability, reliability, and renewable integration—to analyze modern grid requirements. (PI 2.1.3, PI 11.2.2)* *LO1.5* *Combine scientific principles and engineering concepts to develop conceptual models illustrating differences between conventional grids, smart grids, and microgrids to strengthen continuous learning skills. (PI 2.3.1, PI 11.3.1)*	**8**
02.	**Smart Devices, Digital Substation and Communication in Smart Power System** ***Learning Objective:*** *Analyse smart devices, digital substation architectures, and communication technologies to evaluate their roles in achieving efficient and interoperable smart power system operation.* **Contents:** Smart Devices: Intelligent Electronic Devices (IEDs), Architecture, functions, applications, Smart meters & Advanced Metering Infrastructure (AMI), Smart sensors & measurement transducers, Phasor Measurement Units. Digital Substations: Concept & architecture of digital substations, Process bus & station bus overview, IEC 61850 basics, Advantages: interoperability, reduced wiring, faster protection, Substation automation levels. Communication Technologies: Need for communication in modern power systems, Communication media: fiber optics, PLC, RF, cellular, satellite, SCADA; Utility communication protocols.	**8**

	Self-Learning Topics: *Time synchronization in substations (IEEE 1588 PTP), Distributed automation communication architectures*	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply fundamental and advanced engineering knowledge to model smart devices. (PI 1.1.2)* *LO2.2 Apply fundamental engineering concept to solve problems related to the functions and applications of smart devices. (PI 1.3.1)* *LO2.3 Identify, formulate, and analyze engineering problem of achieving efficient and interoperable smart power system operation. (PI 2.1.1)* *LO2.4 Combine scientific principles and engineering concepts to formulate models (mathematical or otherwise) of a smart power system or process, such as the data flow in a digital substation. (PI 2.3.1)* *LO2.5 Determine design objectives, functional requirements, and specifications for integrating Smart Devices and Digital Substations (PI 3.1.6)* *LO2.6 Refine the conceptual communication network design into a detailed digital substation architecture, while operating within resource constraints, Identifying and sourcing information to bridge the gaps on emerging communication standards and adaptability to new technology. (PI 3.4.1, PI 11.1.2)* *LO2.7 Recognize the need and be able to clearly explain why it is vitally important to keep up with new developments in smart power system technologies (PI 11.2.2)*	
03.	**Monitoring and Measurement in Smart Power System**	**8**
	Learning Objective: *Identify and evaluate smart devices, digital substation components, and communication technologies for effective operation of modern power systems.*	
	Contents: Real-time monitoring in modern grids, Phasor Measurement Units (PMUs), Wide Area Monitoring Systems (WAMS), Distribution system monitoring, Feeder monitoring, Voltage and fault detection, Data acquisition & analytics, Health monitoring of transformers, lines & equipment.	
	Self-Learning Topics: *Islanding detection techniques*	
	Learning Outcomes: *A learner will be able to* *LO3.1 Apply fundamental engineering concepts (e.g., circuit theory, signal processing) to solve problems inherent in real-time monitoring in modern grids and the physics of voltage and fault detection. (PI 1.3.1)* *LO3.2 Identify engineering systems, variables, and parameters (e.g., current, voltage, frequency, phase angle) necessary to solve problems in Distribution system monitoring and Feeder monitoring. (PI 2.1.2)* *LO3.3 Analyze existing data for trends and correlations collected from Wide Area Monitoring Systems (WAMS), and use these findings to analyze the sourced technical literature on WAMS protocols. (PI 4.3.2, PI 11.3.2)* *LO3.4 Case study 1: July 30th and 31st 2012 North India blackouts* *Objectives:* • *Evolution: Shift from the conventional grid (Module 1) due to a catastrophic real-world failure.* • *Smart Devices/ Communication: Design and implementation of WAMS, PMUs, and the fiber optic communication network (Module 2).* • *Monitoring: Use of PMU data for real-time analysis, post-facto investigation, and health monitoring (Module 3).* *Or any other relevant case study. (PI 1.3.1, PI 2.3.1, PI 4.3.2, PI 11.3.2)*	
04.	**Operation and Control in Smart Power System**	**8**
	Learning Objectives: *Analyze control strategies and operational tools in smart power systems to enhance reliability, flexibility, and grid efficiency.*	

	Contents: System Operation Overview, SCADA for control centers, Automatic Generation Control (AGC), Power system stability (qualitative), Demand Response, Distributed Automation & Self-Healing Grids, Role of Energy Storage in grid operation, Power electronics in modern power systems.	
	Learning Outcomes: *A learner will be able to* *LO4.1* *Apply fundamental engineering concepts (e.g., control system principles, time-delay analysis) to solve problems inherent in tuning the control loops for Automatic Generation Control (AGC) and maintaining Power system stability. (PI 1.3.1)* *LO4.2* *Apply electrical engineering knowledge to interpret the operational functioning and integration challenges in modern power systems. (PI 1.4.1)* *LO4.3* *Identify engineering systems, variables, and parameters (e.g., control setpoints, communication latencies) necessary to solve problems in coordinating Demand Response events. (PI 2.1.2)* *LO4.4* *Combine scientific principles and engineering concepts to formulate conceptual models (e.g., data flow diagrams, control block diagrams) for processes like the state estimation used by SCADA or the fault isolation logic of Self-Healing Grids. (PI 2.3.1)* *LO4.5* *Determine design objectives, functional requirements, and specifications for implementing control strategies, such as defining the threshold criteria and operational response for a successful Demand Response program. (PI 3.1.6)* *LO4.6* *Refine the conceptual control design for integrating Energy Storage systems (e.g., frequency regulation mode) into a detailed architecture. (PI 3.4.1)*	
05.	**Microgrid and Active Distribution Networks**	**6**
	Learning Objective/s: *Analyze the operational characteristics and benefits of microgrids and active distribution networks.*	
	Contents: **Microgrids:** Concept and components of microgrids, Characteristics of microgrids, Operating modes: grid-connected vs islanded, Control hierarchy (only overview), benefits. **Active Distribution Networks:** Concept of active vs passive distribution networks, Integration of DERs into distribution systems, Bidirectional power flow in distribution systems, Role of smart inverters, Volt-VAR and Volt-Watt control (conceptual), Protection issues in active networks, Role of storage and EVs in active grids.	
	Learning Outcomes: *A learner will be able to* *LO5.1* *Apply fundamental engineering concepts (e.g., power quality, stability) to solve problems inherent in the integration of DERs into distribution systems. (PI 1.1.1)* *LO5.2* *Apply electrical engineering knowledge to interpret the functioning and control hierarchy of a Microgrid (PI 1.4.1)* *LO5.3* *Identify engineering systems, variables, and parameters necessary to solve the problem of mitigating Protection issues in active networks caused by the integration of distributed generation. (PI 2.1.2)* *LO5.4* *Combine scientific principles and engineering concepts to formulate models illustrating the operational differences between active vs. passive distribution networks. (PI 2.3.1)* *LO5.5* *Determine design objectives, functional requirements, and specifications for a Microgrid's core components. (PI 3.1.6)* *LO5.6* *Refine the conceptual control design with existing/ with new developments for integrating the Role of storage and EVs in active grids into a detailed architecture. (PI 3.4.1, PI 11.2.2)*	

	LO5.7 *Source and comprehend technical literature and other credible sources of information regarding the latest control schemes and operating modes for both Microgrids and Active Distribution Networks. (PI 11.3.1)*	
06.	**Cybersecurity in Smart Power Systems** ***Learning Objective/s:*** *Analyze cybersecurity threats and evaluate standards and protective measures to secure modern power system operations.*	**5**
	Contents: Introduction to cyber risks in power systems, Vulnerabilities in modern power system components, Types of cyber-attacks, Cybersecurity standards, Basic mitigation strategies, Building a cyber-resilient smart power system.	
	Learning Outcomes:	
	A learner will be able to *LO6.1* *Apply fundamental engineering concepts (e.g., network protocols, encryption, control system architecture) to solve engineering problems related to securing data flow between the physical and digital domains of the power system. (PI 1.3.1)* *LO6.2* *Identify, formulate, and analyze engineering problem of securing the entire operational technology (OT) environment against emerging cyber risks in power systems. (PI 2.1.2)* *LO6.3* *Combine scientific principles and engineering concepts to formulate conceptual models (e.g., threat models, attack trees) illustrating potential Types of cyber-attacks against control center and substation networks. (PI 2.3.1)* *LO6.4* *Determine design objectives, functional requirements, and specifications for implementing Basic mitigation strategies and protective controls (e.g., firewall rules, intrusion detection systems) to protect critical smart grid assets. (PI 3.1.6)* *LO6.5* *Refine the conceptual design of a security architecture with existing/ with new developments Building a cyber-resilient smart power system, operating within constraints such as latency and regulatory compliance. (PI 3.4.1, PI 11.2.2)* *LO6.6* *Case study 2: October 2020 Mumbai Grid Disturbance/ any other case study.* *Objectives:* • *Operation and Control in Smart Power System. (Module 4)* • *Microgrid and Active Distribution Networks. (Module 5)* • *Cybersecurity in Smart Power Systems. (Module 6)* *Or any other relevant case study. (PI 1.3.1, PI 2.3.1, PI 4.3.2, PI 11.3.2)*	
	Course Conclusion By the end of this course, Learners will have acquired a clear understanding of the structure, operation, and key technologies that define modern smart power systems. Highlighting the role of communication frameworks, automation, renewable integration, and energy storage in enhancing reliability, efficiency, and sustainability of power networks. Equipped with this conceptual foundation, readers will be prepared to engage with emerging trends, standards, and innovations in smart grid design and operation, forming a strong base for advanced study or professional practice in the evolving field of intelligent energy systems.	**1**
	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.
2.1.1	Articulate problem statements and identify objectives

2.1.2 Identify engineering systems, variables, and parameters to solve the problems.
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.2 Identify, assemble and evaluate information and resources.
2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3 Identify sources of error in the solution process, and limitations of the solution.
2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.5 Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural, whole-life cost, net zero carbon, culture, environment and societal issues
3.1.6 Determine design objectives, functional requirements and arrive at specifications.
3.3.1 Apply formal decision-making tools to select optimal engineering design solutions for further development
3.4.1 Refine a conceptual design into a detailed design within the existing constraints (of the resources)
4.1.1 Define a problem, its scope and importance for purposes of investigation.
4.1.4 Establish a relationship between measured data and underlying physical principles
4.3.2 Analyse data for trends and correlations, stating possible errors and limitations.
4.3.4 Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions.
6.3.1 Identify risks/impacts in the life-cycle of an engineering product or activity
6.3.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
6.3.4 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
11.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.1 Source and comprehend technical literature and other credible sources of information
11.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes:

A learner will be able to -

1. Apply knowledge of the power system's historical development to distinguish features of modern smart power systems, including architecture, sustainability drivers, and enabling technologies. *(LO1.1, LO1.2, LO1.3, LO1.4, LO1.5)*
2. Interpret the roles of smart devices, digital substations, and communication technologies in smart power systems. *(LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6, LO2.7)*
3. Identify real-time measurement data, monitoring systems and equipment health indicators to support operational decision-making in smart power systems. *(LO3.1, LO3.2, LO3.3, LO 3.4)*
4. Identify the functions of system operation tools and energy storage in maintaining grid stability and flexibility. *(LO4.1, LO4.2, LO4.3, LO4.4, LO4.5, LO4.6)*
5. Compare microgrid components, operating modes, and active distribution network features. *(LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO5.6, LO5.7)*
6. Integrate cybersecurity measures by identify cyber risks, vulnerabilities, attack types, security standards in smart power systems. *(LO 6.1, LO6.2, LO6.3, LO6.4, LO6.5, LO6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7041.1	3	3				3					3

EEPEC7041.2	3	3	3								3
EEPEC7041.3	3	3		3							3
EEPEC7041.4	3	3	3								
EEPEC7041.5	3	3	3								3
EEPEC7041.6	3	3	3								3
Average	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**3**		**3**

Text Books:

1. J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Hoboken, NJ, USA: Wiley-IEEE Press, 2012.
2. F. P. Sioshansi, *Smart Grid: Integrating Renewable, Distributed and Efficient Energy*, San Diego, CA, USA: Academic Press, 2012.
3. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, and N. Jenkins, *Smart Grid: Technology and Applications*, Chichester, U.K.: Wiley, 2012.

Reference Books:

1. A. Keyhani, *Design of Smart Power Grid Renewable Energy Systems*, 2nd ed., Hoboken, NJ, USA: Wiley, 2016.
2. S. A. Khaparde and S. V. Kulkarni, *Smart Grid: Technology and Applications*, New Delhi, India: McGraw-Hill Education, 2020.
3. J.-C. Sabonnadière and N. Hadjsaïd, *Smart Grids*, London, U.K.: Wiley-ISTE, 2011.
4. S. W. Fardo and D. R. Patrick, *Electrical Power Systems Technology*, Boca Raton, FL, USA: CRC Press, 2015.
5. H. Farhangi, *The Path of the Smart Grid*, Hoboken, NJ, USA: Wiley, 2019.

Other Resources:

1. NPTEL – *Smart Grid: Integration and Control*, IIT Roorkee.
2. NPTEL – *Power System Automation*, IIT Kanpur.

IN-SEMESTER ASSESSMENT (75 MARKS)

1. **Continuous Assessment - Theory-(20 Marks)**

   02 Class tests: (5 marks each)

   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 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	EEPEC7042	Power Quality and FACTS	3

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. EEPCC408 - Power System Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The engineer and society
4. PO8: Individual and team work
5. PO11: Life-long learning

Course Objectives:

1. To impart knowledge on fundamentals of power quality, the generation and effects of harmonics, and their measurement in electrical systems.
2. To introduce methods for power factor improvement, harmonic mitigation, and reactive power control using shunt and series compensators.
3. To teach principles, applications, and significance of FACTS devices and advanced hybrid controllers for voltage stability and power flow control in modern power systems.

Module	Details	Hrs
	Course Introduction Power quality is essential for reliable and efficient operation of electrical systems. Flexible AC Transmission Systems (FACTS) enhance power quality by improving voltage stability, controlling power flow, and mitigating disturbances. Studying power quality and FACTS helps in identifying issues and applying effective solutions.	**01**
01.	**Introduction to Power Quality**	**04**
	Learning Objective/s: *To impart knowledge on various power quality disturbances and their impact on voltage, frequency, and overall system performance.*	
	Content Transient and steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, harmonics, noise, notching, dc-offsets, fluctuations, flicker. Impact of voltage and frequency variation on system reliability	

	Learning Outcomes: *A learner will be able to* *LO1.1 Apply electrical engineering concepts to understand transient and steady-state variations in voltage and frequency (PI 1.4.1)* *LO 1.2 Apply fundamental engineering concepts to understand unbalance, sags, swells, interruptions, harmonics, noise, notching, DC offsets, fluctuations, and flicker. (PI 1.3.1)* *LO1.3 Identify and categorize various power quality disturbances in electrical systems. (PI 2.2.1)* *LO1.4 Analyze the effects of voltage and frequency variations on equipment performance and system reliability. (PI 2.1.3)*	
02.	**Harmonics and its Effects**	**07**
	Learning Objective/s: *To teach causes, characteristics, and effects of harmonics in power systems and their impact on electrical equipment and system performance.*	
	Contents: Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads, Inter-harmonics, Effects of harmonics on rotating Machines, Transformers and Cables, Overloading of Neutral conductor.	
	Self-Learning Topic *FFT analysis of current and voltage waveforms.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1 Apply the principles of harmonic analysis to calculate voltage and current distortions in electrical systems. (PI 1.3.1)* *LO 2.2 Apply harmonic analysis methods to compute harmonic indices and evaluate their impact on electrical systems. (PI 1.4.1)* *LO 2.3 Analyze various sources of harmonics in electrical systems and classifying them (PI 2.4.1)* *LO 2.4 Assess the impact of harmonics on electrical equipment and system reliability. (PI 2.1.3)*	
03.	**Power Quality Improvement**	**09**
	Learning Objective/s: *To teach methods for improving power factor and mitigating power quality issues*	
	Contents: Power factor compensation using capacitor (vector diagram and numerical included), Power factor when both voltage and current are sinusoidal, power factor when voltage is sinusoidal and current is non-sinusoidal (numerical included), Mitigation of harmonics- Passive filters- Advantages and disadvantages of passive filters- Active filters, Instantaneous PQ theory.	

	Learning Outcomes: *A learner will be able to* *LO3.1 Apply capacitor-based compensation for different voltage/current conditions. (PI 1.3.1)* *LO3.2 Analyze and determine the effectiveness of passive and active filters in reducing harmonics and improving power quality in electrical systems. (PI 2.4.2)* *LO3.3 Analyze real systems to detect low power factor and harmonic disturbances. (PI 2.4.1)* *LO3.4 Apply instantaneous PQ theory for real and reactive power control in three-phase systems to improve power quality, demonstrating teamwork and lifelong learning. (PI 1.4.1, PI 8.1.1, PI 11.2.2)*	
04.	**General Concept of FACTS**	**08**
	Learning Objective/s: *To impart knowledge on concept of Flexible AC Transmission Systems (FACTS), their role in reactive power control and their importance in enhancing transmission network performance.*	
	Contents: The concept of flexible AC transmission– Transmission Interconnections, reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network.	
	Self-Learning Topics: *Stability issues in transmission lines.*	
	Learning Outcomes: *A learner will be able to* *LO4.1 Apply the concepts of reactive power to evaluate its impact on voltage regulation in transmission lines. (PI 1.3.1)* *LO4.2 Apply the concepts of FACTS devices to enhance transmission efficiency and system stability. (PI 1.4.1)* *LO4.3 Analyze limitations of uncompensated lines and justify the need for reactive power compensation. (PI 2.2.1)* *LO4.4 Analyze the impact of FACTS implementation on voltage profile, stability, and power flow control. (PI 2.2.4)*	
05.	**Static Shunt and Series Compensators**	**08**
	Learning Objective/s: *To teach various compensation techniques and devices for enhancing the performance and stability of power systems.*	
	Contents Objectives of series and shunt compensation, Variable impedance type static var generator (TCR, TSR, TSC, FC-TCR) description of static var compensators (SVC), thyristor controlled series compensators (TCSC),static synchronous series compensator (SSSC),STATCOM.	
	Learning Outcomes: *A learner will be able to* *LO5.1 Compare shunt vs series compensation and identify suitable compensators for various system requirements. (PI 2.1.3)* *LO5.2. Apply fundamental engineering concepts to understand the working of TCR, TSR, TSC, FC-TCR in controlling reactive power. (PI 1.3.1)*	

	LO5.3 Evaluate the effectiveness of SVC, TCSC and SSSC in improving power system performance through collaborative teamwork in poster creation. (PI 2.4.1, PI 8.3.1) *LO5.4 Apply principles of series and shunt compensation to interpret the operation of STATCOM for dynamic reactive power compensation and voltage regulation in transmission networks. (PI 1.4.1)*	
06.	**Hybrid FACTS Controllers:**	**07**
	Learning Objective/s: *To impart knowledge on principles, operation, and applications of UPFC, IPFC, and static voltage and phase angle regulators in power system control.*	
	Contents: Unified Flow Controller (UPFC)–Principle of operation, modes of operation, applications Power, Interline Power Flow Controller (IPFC). Introduction to Static voltage and phase angle regulators.	
	Learning Outcomes: *A learner will be able to* *LO6.1 Apply the working principles of UPFC, IPFC, and voltage/phase angle regulators to understand their operation in power flow control. (PI 1.4.1)* *LO6.2 Apply UPFC/IPFC modes to match suitable applications in power system networks. (PI 1.3.1)* *LO6.3 Recognize scenarios where hybrid FACTS controllers are required to enhance the reliability, efficiency, and societal benefits of electrical power systems. (PI 2.4.1, PI 6.1.1)* *LO6.4 Evaluate the effectiveness of voltage/phase regulators in minimizing power losses and supporting modern electrical infrastructure. (PI 2.4.2, PI 6.2.1)*	
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4.1	Apply Electrical engineering concepts to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub problems Identify
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.1	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
11.2.2	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:

1. Identify and describe various power quality issues in electrical systems. (*LO1.1, LO1.2, LO1.3, LO1.4)*
2. Apply knowledge to explain the causes and effects of harmonics on electrical equipment. (*LO2.1, LO 2.2, LO 2.3, LO 2.4)*

3. Apply suitable methods to improve power factor and mitigate harmonics. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
4. Analyze the concept and importance of FACTS devices in power systems. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
5. Analyze the operation and applications of shunt and series compensators. (*LO 5.1, LO5.2, LO 5.3, LO 5.4)*
6. Evaluate the performance and significance of hybrid FACTS controller. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7042.1	3	3									
EEPEC7042.2	3	3									
EEPEC7042.3	3	3						2			2
EEPEC7042.4	3	3									
EEPEC7042.5	3	3						2			
EEPEC7042.6	3	3									
Average	3	3						2			2

Text Books :

1. Roger C. Dugan, “Electrical Power Systems Quality”, McGraw-Hill Publication
2. G.T. Heydt, “Electric Power Quality”, Starsina Circle Publications
3. T.J.E. Miller, “Reactive Power Control in Electrical System”, John Wiley and Sons, New York, 1982.
4. N.G. Hingorani, “Understanding FACTS: Concepts and Technology of FACTS Systems”, IEEE Press, 2000

Reference Books :

1. J. Arrillaga ,N.R .Watson, “Power System Quality Assessment”, John Willey & Sons
2. K.R. Padiyar ”FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007

Other Resources:

1. NPTEL course on Power Quality Improvement Technique, IIT Roorkee Prof. Avik Bhattacharya https://nptel.ac.in/courses/108107157
2. NPTEL course on Facts Devices By Prof. Avik Bhattacharya IIT Roorkee https://onlinecourses.nptel.ac.in/noc23_ee58/preview

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
Poster creation: 05 Marks
Case study and report submission: 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
PE	EEPEC7043	Artificial Intelligence in Renewable Energy System	04

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

Pre-requisite :

1. ESL103: Programming Laboratory-II(C)
2. ECMDM6048: Smart Electronic Systems

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering tool usage
4. PO6: The Engineer and the World
5. PO8: Individual and Collaborative Team Work
6. PO9: Communication

Course Objectives :

1. To comprehend the concepts and importance of Artificial Intelligence (AI) in renewable energy systems.
2. To know about the working principles of Artificial Neural Networks (ANN), Fuzzy Logic, and hybrid intelligent systems.
3. To comprehend strength and weakness of problem solving and optimization algorithms.
4. To explore machine learning and deep learning techniques for forecasting, prediction, and fault diagnosis in renewable systems.
5. To develop skills in designing and simulating AI-based control, forecasting, and energy management models using MATLAB and AI frameworks.

Module	Details	Hrs.
	Course Introduction This course introduces intelligent control and prediction techniques for renewable energy systems using Artificial Intelligence (AI) approaches such as Fuzzy Logic, and Artificial Neural Networks (ANN). It focuses on applying these soft computing methods to optimize power generation, manage energy flow, and enhance system reliability in hybrid renewable setups. Students will learn how fuzzy logic and ANN-based algorithms can be designed, trained, and implemented for applications like MPPT control, fault diagnosis, and renewable energy forecasting. By the end of the course, learners will be able to develop intelligent controllers for efficient operation of PV, wind, and hybrid energy systems.	**01**
01.	**Overview of AI Techniques** ***Learning Objective:*** *To comprehend basic AI&ML techniques and its applications in renewable energy systems.*	**7**
	Contents:	

	Introduction to AI: Concept, Scope and Importance. **Challenges in Renewable Energy Systems:** Intermittency, Variability and Storage issues. **AI Techniques:** Machine learning, Fuzzy logic, Neural networks. **AI Applications in Renewable energy systems:** Forecasting, fault detection and control, Predictive maintenance.	
	Self-Learning Topics: *Review IEEE paper based on any one AI application in Renewable energy systems.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental AI concepts to identify the challenges in renewable energy systems. (PI-1.3.1)* *LO 1.2: Apply electrical engineering concepts to assess the challenges in renewable energy systems. (PI-1.4.1)* *LO 1.3: To demonstrate the technical and environmental impacts of AI applications in PV forecasting and battery health diagnostics by examining performance metrics, efficiency gains, and sustainability outcomes. (PI-6.3.2)* *LO 1.4: To explore AI-driven preventive and sustainable engineering methods such as PV inverter fault prediction and optimized battery management to promote efficient energy management. (PI-6.3.4)*	
02.	**ANN for Renewable Energy Systems** ***Learning Objective:*** *To identify different AI learning algorithms to solve engineering problems.*	**7**
	Contents: **ANN architectures:** Feedforward, feedback, multilayer perceptron (MLP). **Learning Algorithms:** Supervised and unsupervised learning, backpropagation. **Applications of ANN in renewable energy:** solar irradiation and temperature forecasting, MPPT control in PV systems.	
	Self-Learning Topics: *MPPT control of PV using suitable AI learning algorithms.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental concepts of different learning algorithms and techniques to solve engineering problems. (PI-1.3.1)* *LO 2.2: Apply electrical engineering concepts to interpret the data and analyze engineering problems. (PI-1.4.1)* *LO 2.3: Identify and apply appropriate learning algorithm/technique to solve problems. (PI-2.1.2)* *LO 2.4: Compare performance of different learning algorithms/techniques and select the most suitable one for a particular AI application. (PI-2.2.4)*	
03.	**Fuzzy Logic systems** ***Learning Objective:*** *To identify the principles of fuzzy logic systems to solve engineering problems.*	**6**
	Contents: **Fundamentals of fuzzy logic:** fuzzy sets, membership functions, and fuzzy inference system. **Applications:** Fuzzy rule based decision making for energy flow control in Microgrids, Fuzzy logic-based MPPT for PV systems.	
	Self-Learning Topics: *MATLAB simulation of fuzzy controller for any one renewable application.*	

	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply fundamental concepts of fuzzy logic systems in intelligent control of renewable energy systems. (PI-1.3.1)* *LO 3.2: Apply electrical engineering concepts to analyze renewable energy system data for fuzzy logic control. (PI-1.4.1)* *LO 3.3: To demonstrate the technical and environmental dimensions adaptive energy management in renewable energy systems and implement fuzzy-logic based preventive control strategies to support sustainable system operation. (PI-6.3.2, PI-6.3.4)*	
04.	**Optimization Algorithms** ***Learning Objectives:*** *Identify suitable optimization algorithms to solve engineering problems.*	**6**
	Contents: **Overview:** Need for optimization algorithms, classical and metaheuristic methods. **Genetic Algorithm (GA):** selection, crossover, mutation, and convergence. **Particle Swarm Optimization (PSO):** velocity and position update, parameter tuning. Applications of GA and PSO in converter parameter tuning.	
	Self-Learning Topics: MATLAB-based simulation of any one-optimization algorithm.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply fundamental principles of optimization algorithms to solve engineering problems. (PI-1.3.1)* *LO 4.2: Apply electrical engineering concepts to analyze suitable data for intelligent control of renewable energy systems. (PI-1.4.1)* *LO 4.3: Identify and apply appropriate optimization algorithm/technique to solve engineering problems. (PI-2.1.2)* *LO 4.4: Compare performance of different optimization algorithms/techniques and select the most suitable one for a particular AI application. (PI-2.2.4)*	
05.	**Machine learning and Deep learning techniques** ***Learning Objective/s:*** *Identify and apply ML/DL architectures for predictive maintenance and fault detection in renewable energy systems.*	**7**
	Contents: **Overview:** Machine learning and deep learning frameworks**,** Regression, classification, and clustering for renewable energy data. Use of SVM for energy prediction. **Deep Learning Architectures**: CNN (Convolutional Neural Network), Data collection and preprocessing for ML/DL models, AI-based predictive maintenance and fault detection in renewable systems.	
	Self-Learning Topics: Exploring tools like MATLAB Predictive Maintenance Toolbox for result visualization.	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply knowledge of engineering fundamentals to develop ML/DL models for renewable energy prediction. (PI-1.3.1)* *LO 5.2: Apply electrical engineering fundamentals to design ML/DL models that accurately forecast renewable energy generation. (PI-1.4.1)* *LO 5.3: Identify suitable ML/DL algorithms to solve renewable energy forecasting and fault detection problems. (PI-2.1.2)*	

	LO 5.4: Assess model performance accurately and understand the implications of various error measures. (PI-2.4.3) LO 5.5: Demonstrate awareness of the role of AI-based predictive maintenance in sustainable and reliable renewable energy operation. (PI-6.3.2, PI-6.3.4)	
06.	**Case studies** ***Learning Objective/s:*** *To enable students to apply machine learning and deep learning techniques for renewable energy forecasting, predictive maintenance, and intelligent energy management.* **Contents:** AI based energy management in micro grids, Fault detection and diagnosis in PV systems, Smart forecasting of Renewable generation, Battery management systems, Recent research trends and future directions in AI for renewable systems. **Note: Case study simulation based assignments will be based on above areas of application of AIML in Renewable energy Systems.** ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply fundamental concepts of AI/ML concepts to solve engineering problems. (PI-1.3.1)* *LO 6.2: Apply electrical engineering concepts to interpret results and determine appropriate solution approaches. (PI- 1.4.1)* *LO 6.3: Examine the solution process to identify the errors and interpret the limitations of the AI-based solution. (PI-2.4.3)* *LO 6.4. Demonstrate the various mathematical assumptions required for modelling of AI/ML enabled sustainable energy systems.(PI-2.3.2)* *LO 6.5: Identify different AI software tools to adapt in Renewable energy domain applications with the help of case study/research literature and submit report for the same as a team. (PI-5.1.1, 5.1.2, 8.2.1, 8.3.1, 9.1.1, 9.1.2)*	**7**
	Course Conclusion This course provides a comprehensive understanding of Machine Learning and Deep Learning models that can be effectively applied to renewable energy systems. Students gain the ability to develop intelligent models for energy forecasting, management, and fault detection in micro grids and photovoltaic systems. By integrating theoretical concepts with practical applications, learners become equipped to analyze real-time renewable energy data, implement AI-based predictive solutions, and explore emerging research trends in sustainable energy technologies.	**01**
	Total	**42**

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.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.

6.3.4 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1 Read, understand and interpret technical and non-technical information.
9.1.2 Produce clear, well-constructed, and well-supported written engineering documents.

Course Outcomes: A learner will be able to –

1. Demonstrate the significance and practical applications of Artificial Intelligence techniques for enhancing the efficiency and sustainability of renewable energy systems. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4).*
2. Apply intelligent learning algorithms to optimize the performance of renewable energy systems and promote sustainable operation. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4).*
3. Apply fuzzy logic controllers to manage energy flow and implement MPPT for renewable energy systems. *(LO 3.1, LO 3.2, LO 3.3)*
4. Employ optimization algorithms for tuning system parameters and improving energy management in renewable energy systems. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4).*
5. Apply ML/DL techniques for fault detection, and predictive maintenance in renewable energy systems. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5).*
6. Apply AI and deep learning techniques to solve engineering problems in the renewable energy domain, work collaboratively in a team, and explore recent research trends to promote sustainable energy solutions. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7043.1	3					3					
EEPEC7043.2	3	3									
EEPEC7043.3	3					3					
EEPEC7043.4	3	3									
EEPEC7043.5	3	3				3					
EEPEC7043.6	3	3			3			3	3		
Average	3	3			3	3		3	3		

Text Books :

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.
5. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", 1st Edition, Morgan-Kaufmann, 1998.
6. R. O. Duda, E. Hart, and D.G. Stork, "Pattern Classification", Second Edition, John Wiley & Sons, Singapore, 2012.

7. Francois Chollet, “Deep Learning with Python”, Manning Publications, Shelter Island, New York, 2018.

Reference Books :

1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, “Artificial Intelligence”, McGraw Hill, 3rd ed.,2017.
2. Patterson, “Introduction to Artificial Intelligence & Expert Systems”, Pearson, 1st ed. 2015.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH
5. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, MIT Press, 2014.
6. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
7. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
8. Navin Kumar Manaswi, “Deep Learning with Applications using Python”, A press, New York, 2018.

Other Resources :

1. NPTEL Course: Artificial Intelligence and Machin Learning, Prof. Krishanu Biswas, IIT Kanpur https://onlinecourses.nptel.ac.in/noc24_ce107/preview.

IN-SEMESTER ASSESSMENT (50 MARKS)

Continuous Assessment - Theory-(20 Marks)

Case Study Assignments: 10 Marks
Flipped Classroom: 5 Marks
Regularity and Active Participation: 5 Marks

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
OEC	OEC7011	Product Life Cycle Management	03

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

Program Outcomes addressed:

1. PO3 : Design / Development of Solutions
2. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction to Product Lifecycle Management (PLM)**	**9-11**
	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications, PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	
02.	**Product Design**	**9-11**
	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	

03.	**Product Data Management (PDM)**	**5-7**
	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
04.	**Virtual Product Development Tools**	**5-7**
	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05.	**Integration of Environmental Aspects in Product Design**	**5-7**
	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06.	**Life Cycle Assessment and Life Cycle Cost Analysis**	**4-6**
	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7011.1	-	-	-	-	-	3	-	-	-	3	-
OEC7011.2	-	-	3	-	-	-	-	-	-	3	-
OEC7011.3	-	-	3	-	-	-	-	-	-	-	-
OEC7011.4	-	-	3	-	-	-	-	-	-	3	-
Average	-	-	**3**	-	-	**3**	-	-	-	**3**	-

References :

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105

2. Fabio Giudice, Guido La Rosa, Antonino Risitano, “Product Design for the environmentA life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC7012	Reliability Engineering	03

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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 5: Engineering Tool Usage

Course Objectives:

1. To familiarize the students with various aspects of probability theory.
2. To acquaint the students with reliability and its concepts.
3. To introduce the students to methods of estimating the system reliability of simple and complex systems.
4. To understand the various aspects of Maintainability, Availability and FMEA procedure.

Module	Details	Hrs.
	Course Introduction Reliability Engineering is a vital discipline within engineering that focuses on ensuring systems and components perform their intended functions consistently over their expected lifetime. The course introduces students to the principles, tools, and methodologies used to analyze, predict, and improve the reliability of engineering systems. Students will explore key concepts such as failure mechanisms, probability models, reliability metrics, system configurations, maintenance strategies, and life data analysis. Through theoretical understanding and practical applications, the course aims to develop the ability to design reliable products, evaluate system performance, and implement reliability improvement programs in real-world engineering environments. By the end of the course, learners will gain a strong foundation in reliability concepts and become capable of applying these principles across various domains including mechanical, electrical, electronic, and manufacturing systems.	**01**
	Contents:	

	Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Rules for combining probabilities, independent, mutually exclusive, complimentary, conditional events, simultaneous occurrence of events.	
02.	**Reliability Concepts** **Contents:** Reliability definitions, Reliability functions, Importance of Reliability, Quality Assurance and Reliability. Failure- causes of failures, modes of failures, Bath Tub Curve Failure Data Analysis: Failure density, Mean Time to Failure (MTTF), Mean time between failure (MTBF).	**7-9**
03.	**Reliability Hazard Models** **Contents:** Hazard rate, Constant Hazard, Hazard Models –Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution MTTF in terms of failure Density, Mean time in failure in integral form functions and reliability analysis.	**6-8**
04.	**System Reliability** **Contents:** System Configurations: Series, parallel, mixed configuration, k- out of n structure, Complex systems. Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	**5-7**
05.	**Maintainability and Availability** **Contents:** Maintainability, System Down time, Reliability and Maintainability tradeoff. Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability– qualitative aspects, Availability measures	**7-9**
06.	**Failure Mode, Effects & Criticality Analysis and Fault Tree Analysis** **Contents:** Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, Fau1t tree analysis and Event Tree Analysis. Fault Tree Analysis, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event Tree Analysis.	**7-9**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply the concept of Probability theory to engineering problems.
2. Understand fundamental concept of reliability to calculate different reliability parameters.
3. Differentiate between reliability hazard models.
4. Illustrate the understanding of System Reliability.

5. Illustrate the various aspects of Maintainability and Availability
6. Familiarize with the FMECA and able to construct fault tree diagrams.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7012.1	3	3	--	--	--	--	--	--	--	--	--
OEC7012.2	3	3	--	--	3	--	--	--	--	--	--
OEC7012.3	3	3	--	3	--	--	--	--	--	--	--
OEC7012.4	3	3	3	3	--	--	--	--	--	--	--
OEC7012.5	3	3	3	--	--	--	--	--	--	--	--
OEC7012.6	3	3	3	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**3**	**3**	--	--	--	--	--	--

Text Books :

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. E. Balagurusamy, “Reliability Engineering”, Mcgraw Hill Education (India), 2003.

Reference Books :

1. P.D.T. Conor, “Practical Reliability Engineering”, John Wiley & Sons, 1985.
2. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.3
3. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Other Resources :

1. Introduction to Reliability Engineering
   Link - https://nptel.ac.in/courses/127105234

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 Marks)

Suggested breakup of distribution

Class Test	:	05 Marks
MCQ test as per GATE exam pattern / level	:	05 Marks
Open book Test	:	05 Marks
Regularity and active participation	:	05 Marks

1. 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
OEC	OEC7013	Management Information System	03

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

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction To Information Systems (IS)**	**3-5**
	Contents: Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
02.	**Data and Knowledge Management**	**7-9**
	Contents: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	
03.	**Ethical issues and Privacy**	**7-9**
	Contents: Information Security. Threat to IS, and Security Controls	
04.	**Social Computing (SC)**	**7-9**
	Contents: Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
05.	**Computer Networks**	**6-8**
	Contents: Wired and Wireless technology, Pervasive computing, Cloud computing model	
06.	**Information System within Organization**	**7-9**

	Contents: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Explain how information systems Transform Business.
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7013.1	3	-	-	-	-	3	-	-	-	-	-
OEC7013.2	3	-	-	-	-	3	-	-	-	-	-
OEC7013.3	3	-	-	-	-	-	-	-	-	-	-
OEC7013.4	3	-	-	-	-	-	-	-	-	3	-
OEC7013.5	3	-	-	-	-	-	-	-	-	3	-
Average	**3**	-	-	-	-	3	-	-	-	3	-

References :

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC7014	Design of Experiments	03

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

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO4 : Conduct Investigations of Complex Problems
4. PO5 : Engineering Tool Usage

Course Objectives :

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction**	**5-7**
	Contents: Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology	
02.	**Fitting Regression Models**	**8-10**
	Contents: Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit	
03.	**Two-Level Factorial Designs** **Contents:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs	**7-9**
04.	**Two-Level Fractional Factorial Designs** **Contents:** The One-Half Fraction of the 2k Design, The One-Quarter Fraction of the 2 k Design, The General 2k-p Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs	**7-9**
05.	**Response Surface Methods and Designs** **Contents:**	**7-9**

	Introduction to Response Surface Methodology , The Method of Steepest Ascent, Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces	
06.	**Taguchi Approach** **Contents:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples	**3-5**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7014.1	3	3	-	3	-	-	-	-	-	-	-
OEC7014.2	3	3	-	-	3	-	-	-	-	-	-
OEC7014.3	3	-	-	3	3	-	-	-	-	-	-
Average	**3**	**3**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**

References :

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3 rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7015	Operation Research	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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO6: The Engineer & The world
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the concept of formulation of a real-world problem as a mathematical programming model.
2. To impart the knowledge of the mathematical tools that are needed to solve optimization problems.
3. To make learner able to use mathematical software to solve the proposed models.
4. To impart the mathematical understanding to analyse and solve integer programming from a wide range of applications.

Module	Detailed Contents	Hrs
	Course Introduction Operations Research (OR) course is an interdisciplinary field that applies advanced analytical, mathematical, and statistical methods to make better decisions in complex systems, optimizing processes and resource allocation. Students learn to identify problems, formulate mathematical models like linear programming, and use algorithms to find optimal solutions for real-world issues in areas such as engineering, management, finance, and logistics.	**01**
01.	**Introduction to Operations Research** **Content:** Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method, Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation	**15-17**

	problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02.	**Queuing models**	**04-06**
	Contents: Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population.	
03.	**Simulation**	**06-08**
	Contents: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04.	**Dynamic programming**	**06-08**
	Contents: Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	
05.	**Game Theory**	**04-06**
	Contents: Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
06.	**Inventory Models**	**04-06**
	Contents: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Apply simplex method, analyse the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change
3. Solve specialized linear programming problems like the transportation and assignment problems.

4. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
5. Analyse the applications of integer programming and a queuing model and compute important performance measures

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7015.1	3	3	3	-	-	-	-	-	-	-	-
OEC7015.2	3	3	-	-	-	-	-	-	-	-	-
OEC7015.3	3	3	3	-	-	3	-	-	-	3	3
OEC7015.4	3	3	3	-	-	3	-	-	-	3	3
OEC7015.5	3	3	3	-	-	3	-	-	-	-	3
Average	**3**	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**

Text Books :

1. Operations Research - An Introduction, Taha, H.A., Seventh Edition 2002, Prentice Hall.
2. Operations Research, S. D. Sharma, First Edition, 2012, KedarNath Ram Nath-Meerut Company
3. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Twentieth Edition, 2022 Sultan Chand & Sons

Reference Books :

1. Operation Research-Methods and problems, Saiesini M.,Yaspan A., First Edition, 1959, Prentice Hall
2. Operations Research: Principles and Practice, Ravindran, A, Phillips, D. T and Solberg, J. J., Second edition, 2009, John Willey and Sons.
3. Introduction to Operations Research, Hiller, F. S. and Liebermann, G. J., Fourth edition, 2002, Tata McGraw Hill

Other Resources :

1. NPTEL Course: Introduction to Operation Research, Prof. G.Srinivasa, IIT Madras
   Web Link- https:// nptel.ac.in/courses/110106062
2. NPTEL Course: Operations Research, Prof. Kusum Deep, IIT Roorkee
   Web Link- https://onlinecourses.nptel.ac.in/noc22_ma48/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7016	Cyber Security and Laws	03

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

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design and Development of Solution
4. PO 4: Conduct investigation of Complex Problem
5. PO 5: Engineering Tool Usage
6. PO 11: Life-long learning

Course Objectives:

1. To define and categorize various forms of cybercrime, including malware attacks, social engineering, financial fraud, and network intrusions, while understanding their technical and societal impacts.
2. To analyse the legal frameworks governing cyber activities, with a focus on distinguishing between different types of cyber laws at national and international levels.
3. To examine the key provisions and structure of the Indian IT Act, 2008, and to evaluate the implications of its latest amendments on digital governance, privacy, and cybercrime adjudication.
4. To identify and compare global information security standards and compliance frameworks, such as ISO 27001, PCI-DSS, GDPR, HIPAA, and NIST, and their relevance to organizational security postures.
5. To apply legal and compliance knowledge in practical scenarios, enabling students to assess organizational compliance requirements and recommend appropriate security controls within legal boundaries.

Module	Details	Hrs.
	Course Introduction This course provides a comprehensive introduction to the principles, practices, and legal frameworks of cyber security. Students will explore various types of cybercrimes, attack methodologies, and defensive strategies, with a strong emphasis on legal and regulatory compliance. The course covers Indian cyber laws and compliances, including the IT Act 2000 and its amendments, as well as global security standards. Through theoretical insights, learners will be equipped to identify, analyse, and respond to cyber threats within a legal and ethical context.	**01**
01.	**Introduction to Cybercrime**	**5-6**
	Contents: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	
02.	**Cyber offenses & Cybercrime**	**7-8**
	Contents: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	
03.	**Tools and Methods Used in Cyberspace**	**7-8**
	Contents: Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
04	**The Concept of Cyberspace**	**7-8**
	Contents: The Concept of Cyberspace, E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange, Law Relating to Electronic Banking, The Need for an Indian Cyber Law.	
05	**Indian IT Act**	**5-6**
	Contents: Cyber Crime and Criminal Justice, Penalties under the IT Act, 2000, Adjudication Mechanism, Appeals under the IT Act, Information Technology Act, 2000, IT Act, 2008 and its Amendments.	
06	**Information Security Standard compliances**	**4-5**
	Contents: SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	
	Course Conclusion	

	This course equips learners with essential knowledge of cybercrime, cybersecurity practices, and cyber laws governing the digital ecosystem. Students gain an understanding of the Indian IT Act and its amendments, various aspects of cyber law, cybercrime investigation and adjudication processes, and major information security compliance standards. Overall, the course enables learners to analyze cyber threats, interpret legal and regulatory requirements, and apply security and compliance principles for secure and lawful use of information systems.	**01**
	Total	**45**

Course Outcomes: A learner will be able to –

1. Classify various types of cybercrimes, cyber threats, and attack techniques, and analyze their technical and societal impacts in digital environments.
2. Analyze cyberattack scenarios and security challenges to identify vulnerabilities, attack vectors, and appropriate technical and organizational security measures.
3. Interpret and apply provisions of the Indian Information Technology Act, 2000 and its amendments to address cybercrime investigation, adjudication, and legal issues.
4. Analyze different aspects of cyber law, including cyberspace governance, e-commerce, digital contracts, intellectual property, electronic evidence, and criminal liability.
5. Apply cybersecurity, legal, and compliance knowledge to real-world scenarios to recommend lawful, secure, and compliant practices in the design and use of information systems.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OCE7016.1	3	-	-	-	-	-	-	-	-	-	-
OCE7016.2	3	3	3	3	3	-	-	-	-	-	3
OCE7016.3	3	3	-	-	-	-	-	-	-	-	-
OCE7016.4	3	3	-	-	-	-	-	-	-	-	-
OCE7016.5	3	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**

Text Books:

1. Nina Godbole, Sunit Belapure, “Cyber Security”, Wiley India, New Delhi.
2. “The Indian Cyber Law” by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3. “The Information technology Act, 2000”; Bare Act- Professional Book Publishers, New Delhi.

Reference Books:

1. “Cyber Law & Cyber Crimes” By Advocate Prashant Mali; Snow White Publications, Mumbai.
2. William Stallings, “Cryptography and Network Security”, Pearson Publication.

3. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.

Other Resources:

1. The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2. A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer professionals-33538

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

One MCQ test as per GATE exam pattern/ level: 05 marks.

One Class test: 05 Marks

One 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%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
OEC	OEC7017	Digital Business Management	03

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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solution
4. PO5: Modern tool Usage
5. PO7: Ethics

Course Objectives:

1. To familiarize students with fundamental concepts, models, and transformation drivers that define digital business ecosystems.
2. To convey strategic frameworks, digital roadmaps, organizational readiness, and performance metrics used in digital transformation.
3. To explain key digital marketing techniques, customer acquisition methods, automation tools, and attribution models.
4. To provide understanding of ecommerce and Omni channel operations, including platforms, logistics, payments, and customer service systems.
5. To develop competency in data-driven decision-making, analytics tools, dashboards, SQL basics, and AI applications in business.
6. To familiarize with platform business models, API integrations, agile/lean product development, and ethical, legal, and security considerations in digital environments.

Module	Details	Hrs.
	Course Introduction Digital Business Management focuses on how digital technologies transform traditional business systems, processes, and decision-making. This course introduces foundations of digital business, digital strategy, marketing, ecommerce, data analytics, platforms, and product delivery, emphasizing the differences between traditional and digital business models. With growing reliance on cloud platforms, analytics, AI, and Omni channel systems, engineering graduates must understand how technical solutions enable digital transformation and value creation. The course equips with managerial and	**01**

	analytical perspectives required to design, evaluate, and manage technology driven business solutions in modern digital enterprises.	
01.	**Foundations of Digital Business** **Contents:** Introduction to Digital Business: Definition and scope Key terminology: digitization, digitalization, transformation Traditional vs Digital Business Models Digital Transformation Drivers Digital Maturity & Culture Digital Business Models – Marketplaces, Subscription, Freemium, PaaS, Value Chains Network Effects & Customer Experience	**06-08**
02.	**Digital Strategy & Transformation** **Contents:** Strategy Frameworks for Digital Initiatives Organizational Change & Governance Digital Roadmap Development Digital Leadership skills: innovation, risk-taking, cross-functional alignment Metrics for Digital Success (Engagement, Retention, Lifetime Value, Customer Acquisition Cost) KPI Dash boarding & Review	**06-08**
03.	**Digital Marketing & Customer Acquisition** **Contents:** Digital Marketing Fundamentals Search Engine Optimization & Search Engine Marketing Basics Social Media & Influencer Marketing Content Marketing & Campaign Design Customer Journey Mapping Personalization & CRM Tools Attribution Models & Optimization Campaign optimization: A/B testing basics	**06-08**
04.	**Ecommerce & Omni channel Operations** **Contents:** Ecommerce Models (B2B, B2C, C2C, D2C) Payments, Fulfilment, Returns, Last-mile Logistics Omni channel Commerce Inventory Visibility & Order Management Digital Customer Service Tools Platform Selection & vendor Evaluation	**06-08**
05.	**Data, Analytics & AI for Business** **Contents:** Data-driven Decision Making Data Pipelines & SQL Basics Descriptive & Diagnostic Analytics Predictive Analytics Recommendation Engines KPI Dashboards (Tools)	**07-09**

	Communicating Data Insights	
06.	**Platforms, Ecosystems, Product Delivery & Ethics**	**06-08**
	Contents: Platform Business Models & Ecosystems Product Management Basics Agile & Lean Startup API Economy & Partnerships Ethical, Legal & Security Considerations	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: A learner will be able to -

1. Summarize the fundamental concepts, models, transformation drivers and customer experience elements of digital business.
2. Analyse the digital strategies, organizational reediness, transformation plans & business performance metrics to evaluate digital initiatives.
3. Apply digital marketing, customer acquisition methods, automation tools, and attribution techniques to develop data driven marketing insights.
4. Classify ecommerce and omnichannel models, evaluate digital platform, and analyse operational workflow to propose process improvements.
5. Use analytical tools, dashboards, SQL fundamental and AI concepts to interpret business data and communicate insights effectively.
6. Analyse platform ecosystem, select product development methodologies, interpret API based integrations and identify ethical/ legal concerns in digital system.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7017.1	3	3	-	-	-	-	-	-	-	-	-
OEC7017.2	3	3	3	-	-	-	-	-	-	-	-
OEC7017.3	-	3	3	-	3	-	-	-	-	-	-
OEC7017.4	-	3	-	-	3	-	-	-	-	-	-
OEC7017.5	-	3	-	-	3	-	3	-	-	-	-
OEC8028.6	-	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**

Text Books :

1. K. C. Laudon and J. P. Laudon, Management Information Systems: Managing the Digital Firm, latest ed. Harlow, U.K.: Pearson Education.
3. D. L. Rogers, The Digital Transformation Playbook: Rethink Your Business for the Digital Age, New York, NY, USA: Columbia Business School Publishing, 2016.
K. Sandeep & J. J. Jose, Digital Business Management, Himalaya Publishing House.
4. A. Osterwalder and Y. Pigneur, Business Model Generation, Hoboken, NJ, USA: Wiley, 2010.
5. E. Brynjolfsson and A. McAfee, The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, New York, NY, USA: W. W. Norton & Company, 2014.
6. P. Kotler, H. Kartajaya, and I. Setiawan, Marketing 5.0: Technology for Humanity, Hoboken, NJ, USA: Wiley, 2021.

Reference Books :

1. T. Eisenmann, G. Parker, and M. Van Alstyne, Platform Revolution: How Networked Markets Are Transforming the Economy, New York, NY, USA: W. W. Norton & Company, 2016.
2. R. T. Rust, M.-H. Huang, and S. J. Lin, Service Analytics and Digital Transformation, Springer, Cham, Switzerland, 2019.
3. S. Sharda, D. Delen, and E. Turban, Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th ed. Boston, MA, USA: Pearson, 2020.
4. M. Porter and J. Heppelmann, How Smart, Connected Products Are Transforming Companies, Boston, MA, USA: Harvard Business Review Press, 2015.
5. A. Chaffey and F. Ellis-Chadwick, Digital Marketing: Strategy, Implementation and Practice, 8th ed. Harlow, U.K.: Pearson Education, 2022.

Other Resources :

1. Digital Business – IIT Kharagpur (Prof. S. Ray) NPTEL Course – Highly aligned with Digital Strategy, Platforms, Digital Models.
2. Marketing Management – IIT Roorkee / IIT Kanpur (Digital marketing modules included) Covers customer journey, campaigns, analytics basics.
3. Introduction to Industry 4.0 and Industrial Internet of Things – IIT Kharagpur Useful for Module 1 (Digital Transformation Drivers).

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested break up of distribution:

a) Activities/Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)
Mid semester examination will be based on 40% to 50% syllabus.

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
OEC	OEC7018	Energy Audit And Management	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: NIL

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: Life-long learning

Course Objectives:

1. To understand the importance of energy security in achieving sustainable development and to learn the fundamental principles of energy conservation.
2. To introduce performance evaluation criteria for electrical and thermal installations to support effective energy management.
3. To utilize data obtained from performance evaluations to identify and prioritize energy-saving measures.

Module	Details	Hrs.
	Course Introduction Energy is a critical resource for economic growth, industrial productivity, and sustainable development. With rising energy costs, increasing demand, and growing environmental concerns, efficient use of energy has become essential across all sectors. Energy Audit and Management focuses on the systematic evaluation, monitoring, and optimization of energy consumption to improve efficiency, reduce operating costs, and minimize environmental impact. This course introduces the principles and practices of energy management, including energy auditing techniques, energy efficiency measures, and the use of modern tools for energy analysis. Students will learn how to assess energy usage in industrial, commercial, and residential facilities, identify energy-saving opportunities.	**01**
01.	**Energy Scenario**	**5-7**
	Contents:	
	Primary and Secondary Commercial and non- commercial energy Renewable and Non Renewable Energy, Present Global and Indian Energy Scenario, Energy Security, Energy Conservation and its	

	Importance, Energy efficiency benefits. Energy Conservation Act-2001 and its Features. Schemes of BEE under EC Act-2001.	
02.	**Energy Audit Principles:**	**8-10**
	Contents: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments. Elements of monitoring& targeting, benefits of M&T; Data and information-analysis. Investment need, Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	
03.	**Energy Management and Energy Conservation in Electrical System:**	**9-11**
	Contents: Basics of Electrical Energy, power factor, Motor loading calculations, relationship between power, voltage and current. Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, harmonics. Energy efficiency measures in lighting system, lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers, General energy saving opportunities in lighting system, Energy conservation opportunities in induction motors, Energy efficient motors, Motor retrofitting, soft starters, variable speed drives. Case studies based on P.F improvement, EEM, Lighting system	
04.	**Energy Management and Energy Conservation in Thermal Systems:**	**9-11**
	Contents: Thermal Energy basics, specific heat, sensible heat, latent heat, energy content in fuel, Heat transfer basics Energy unit and conversions. Review of different thermal loads: Boiler System, performance evaluation of boilers, energy conservation opportunities in boiler Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, efficient steam utilization and energy saving opportunities. Characteristics of efficient furnace, performance evaluation of a typical fuel fired furnace, general fuel economy measures in furnaces Need and benefits of insulation, simplified formula for heat loss calculation, Purpose of heat exchanger, LMTD HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and energy savings opportunities.	

	Case Studies based on boiler, furnace and insulation	
05.	**Energy Performance Assessment:**	**3-5**
	Contents: On site Performance evaluation techniques, Energy performance assessment and its improvement: lighting system, Installed Load Efficacy Ratio (ILER) method, Motor, Heat Exchanger-LMTD, Boiler and Furnace.	
06.	**Energy conservation in Buildings:**	**3-5**
	Contents: Energy Conservation Building Codes (ECBC), ECBC guidelines on HVAC system, lighting system, Electric power, energy efficiency measures in buildings, Energy performance assessment of buildings, Green Building.	
	Course Conclusion This course provides a comprehensive understanding of energy auditing principles and energy management practices. Learners gain knowledge of energy consumption patterns, audit methodologies, and energy performance evaluation techniques for electrical and thermal utilities. The course emphasizes the identification of energy conservation opportunities, and implementation of energy-efficient technologies.	**01**
	Total	**45**

Course Outcomes :

1. Understand global and Indian energy scenario, Energy Conservation Act-2001, ECBC guidelines, to promote energy-efficient and sustainable buildings.

2. Conduct energy audits, analyse energy performance, identify energy-saving opportunities, and evaluate the financial feasibility of energy conservation measures.

3. Apply energy efficiency measures in lighting and motor systems, improve power factor, and identify practical energy conservation opportunities through case studies.

4. Apply energy-saving opportunities in boilers, furnaces, steam distribution, insulation, and HVAC systems, and practical solutions through case studies to improve energy efficiency.

5. Analyse the energy performance of lighting, motors, boilers, furnaces, and heat exchangers on-site and recommend effective energy-saving improvements.

CO-PO mapping table with correlation level:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7018.1	3	-	-	-	-	3	-	-	-	-	-
OEC7018.2	3	3	-	3	-	3	-	-	-	-	3
OEC7018.3	3	-	-	-	-	-	-	-	-	-	-
OEC7018.4	3	-	-	-	-	-	-	-	-	-	-
OEC7018.5	-	3	-	-	-	3	-	-	-	-	3
Average	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**

Text Books:

1. General Aspects of Energy Management and Energy Audit, BEE, Fourth Edition,2015
2. Energy Efficiency in Thermal Utilities, BEE, Fourth Edition,2015
3. Energy Efficiency in Electrical Utilities, BEE, Fourth Edition,2015
4. Energy Performance Assessment for Equipment and Utility Systems, BEE, Fourth Edition,2015

Reference Books:

1. Handbook of Electrical Installation Practice, by Geoffrey Stokes, Blackwell Science, 4th Edition
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Web References:

1. http://www.bee-india.nic.in/
2. https://nceexam.in/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. **Continuous Assessment (20 Marks)**
   - 01 MCQ test: 05 Marks
   - 01 Class test: 10 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
OEC	OEC7019	Development Engineering	03

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

Pre-requisite: NIL

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Module	Details	Hrs
	Course Introduction	**01**
01.	**Introduction to Rural Development**	**8-10**
	Contents: Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
02.	**Post-Independence rural Development**	**4-6**
	Contents: Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
03.	**Rural Development Initiatives in Five Year Plans**	**6-8**

	Contents: Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
04.	**Post 73rd Amendment Scenario**	**4-6**
	Contents: 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	
05.	**Values and Science and Technology**	**10-12**
	Contents: Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	
06.	**Ethics**	**3-5**
	Contents: Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7019.1	-	-	-	-	-	3	-	-	-	-	-
OEC7019.2	-	-	-	-	-	3	-	-	-	-	-
OEC7019.3	-	-	-	-	-	3	-	-	-	-	-
OEC7019.4	-	-	-	-	-	3	-	-	-	-	3
OEC7019.5	-	-	-	-	-	3	3	-	-	-	-
OEC7019.6	-	-	-	-	-	3	3	-	-	-	3
Average	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**3**

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
LC	EELBC710	Electrical System Design and Audit Lab	01

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

Pre-requisite:

1. ESC102- Basic Electrical Engineering
2. EEPCC408 Power System Engineering
3. EEPCC509 Electrical Machines
4. EEPCC510 Protection and Switchgear

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO6: The Engineer and The World
5. PO8: Individual and team work
6. PO9: Communication
7. PO10: Project management and finance
8. PO11: Life-long learning

Course Objectives:

1. To comprehend various electrical drawings and their application in electrical projects
2. To comprehend design of distribution substation and selection/sizing of cable and other auxiliary systems
3. To study data information analysis techniques and electrical load management techniques to apply in Energy audit project.
4. To study various energy efficient technologies and their applications in electrical installations

Module	Details	Hrs
	Course Introduction Electrical system design is an important aspect of an electrical installation. It deals with safety, reliability, compliance, efficiency, future proofing, cost effectiveness and sustainability in the electrical system design across various electrical installations. Electrical system auditing plays a crucial role in ensuring energy efficiency, cost savings, safety, reliability documentation, and continuous improvement in electrical systems.	
01.	**Introduction to Institute Electrical Installation**	**06**
	Learning Objective: *To impart the knowledge of different electrical drawings used in electrical projects and different equipment used in distribution substation and apply the acquired skill to develop single line diagram of their own house.*	
	Theme for conducting experiment: **1.** Demonstration of Single line diagram of our institute power distribution network and other electrical drawings used in the electrical installation such as Panel drawing, lighting and power plans. ***Learning Outcomes:*** *A learner will be able to*	

	LO1.1: Identify various components of electrical drawings such as single line diagram, panel drawings, lighting plan, Bill of Quantities and recognize their specifications at professional level in an electrical projects. (PI-2.2.2, 2.4.4, 9.1.1, 9.1.2, 11.1.1, 11.3.1)	
	Theme for conducting experiment: **2.** Visit to Institute Electrical Distribution Substation, Electrical LT panel room etc. and identify various electrical system and protection equipment in the substation. (report based on the substation Visit) ***Learning Outcomes:*** *A learner will be able to* *LO1.2: Identify various electrical system and protection equipment in the substation and describe their engineering roles towards the protection of the public and produce well-structured engineering report (PI-2.1.2, 6.1.1, 9.1.2,9.3.1)*	
02.	**Design of Distribution Substation**	**06**
	Learning Objective: *To impart knowledge and skill required for the selection and sizing of distribution transformer, feeder, other metering and protection equipment in the distribution network.*	
	Theme for conducting experiment: **1.** Design of a distribution transformer and metering and protection devices and develop single line diagram of given power distribution network. ***Learning Outcomes:*** *A learner will be able to* *LO2.1: Identify various components of a power distribution network and determine design objectives to arrive at their specifications referring to the protection of public and safety and reframe the network in the form of well-structured SLD. (PI-2.1.2, 2.2.1, 3.1.4, 3.1.6, 6.1.1, 9.1.2, 9.3.1, 11.1.1)*	
	Theme for conducting experiment: **2.** Design of underground cables as a feeder for the given power distribution network. ***Learning Outcomes:*** *A learner will be able to* *LO2.2: Explore and synthesize engineering requirements of underground cable design and determine their design objectives for a given power distribution network and arrive at their specifications referring to the protection of public and safety. (PI-3.1.4, 3.1.6, 6.1.1, 9.1.2, 11.1.1)*	
03.	**Data Information Analysis and Energy Audit**	**10**
	Learning Objective: *1. To impart the knowledge of data information analysis techniques to apply and analyse energy performance of the given electrical installation.* *2. To teach the methodology to conduct Energy Audit and apply the skill acquired to conduct energy audit in any electric utility in the institute*	
	Theme for conducting experiment: **1.** Analyze the energy performance of the given electrical installation using CUSUM analysis technique. ***Learning Outcomes:*** *A learner will be able to* *LO3.1: Represent the energy data in a graphical form and analyze the data for trends and correlations using data information analysis techniques to reach to an appropriate conclusions about the energy performance of the plant. (P.I.- 4.3.2, 4.3.3, 4.3.4, 6.3.2, 9.1.2, 11.1.1)*	
	Theme for conducting experiment: **2.** Analyze the performance of different induction motors. ***Learning Outcomes:***	

	A learner will be able to *LO 3.2: Design and develop experimental approach to measure the different physical quantities and analyze the performance of electrical installation. (PI- 4.2.1, 8.1.1, 9.1.2, 11.1.1)*	
	Theme for conducting experiment: ***3.*** Conduct the energy audit of anyone electrical installations in the campus. (Class room, Lift, Seminar hall, Canteen etc.) ***Learning Outcomes:*** *A learner will be able to* *LO 3.3: Design and develop experimental approach and apply appropriate instrumentation to conduct energy audit of electrical installations and synthesize information to reach to the appropriate conclusions. (PI- 4.1.3, 4.2.1,4.3.4, 6.3.3, 8.1.1, 9.1.2, 11.1.1)*	
04.	**Energy Efficient Technologies** ***Learning Objective:*** *To convey the skill required to identify energy efficient technology for the given electrical installation and analyze its effectiveness on the economical basis.*	**08**
	Theme for conducting experiment: **1.** Case study of analyzing the economics of Power Factor Improvement for a given installation and its impact towards reduction in commercial electricity bill. ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Determine the design objectives to select appropriate target power factor for the power factor improvement of the given electrical installations based on the energy optimization and Techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.1)*	
	Theme for conducting experiment: **2.** Case study of analyzing the effectiveness of TOD tariff towards implementing effective load management and reducing Energy Bill. ***Learning Outcomes:*** *A learner will be able to* *LO 4.2: Analyze commercial electricity bills if an electrical installation and decide appropriate load shifting to a different time slot and analyze its effectiveness on the basis of energy bill optimization with techno-economic considerations. (P.I.-3.2.3, 6.3.1, 9.1.2,10.2.1, 11.1.1, 11.3.2)*	
	Theme for conducting experiment: **3.** Case study of analyzing the effectiveness of Motor retrofit Program towards achieving energy efficiency in the given electrical installations. ***Learning Outcomes:*** *A learner will be able to* *LO 4.3: Determine the design objectives to select appropriate standard motor or energy efficient motor based on energy optimization and Techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.1)*	
	Theme for conducting experiment: **4.** Case study of comparing Energy Efficient Lighting Design (EELD) with Standard lighting design in terms of Lighting Power Density. ***Learning Outcomes:*** *A learner will be able to* *LO 4.4: Determine the design objectives to select appropriate lighting system for the given electrical installation based on energy optimization and techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.)*	
	Minimum 2 experiments from each module and total 8 experiments	

Performance Indicators:

P.I. No.	P.I. Statement
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.1	Reframe complex problems into interconnected sub-problems
2.2.2	Identify, assemble and evaluate information and resources.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
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
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
4.3.2	Analyse 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
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 global, regional and local level
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
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.
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
10.2.1	Analyse and select the most appropriate proposal based on economic and financial considerations.
11.1.1	Describe the rationale for the requirement for continuing professional development.
11.3.1	Source and comprehend technical literature and other credible sources of information
11.3.2	Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes:

Learner will be able to

1. **Identify and Analyse** different electrical drawings used in an electrical project and **produce** technical report on Institute substation visit. *(LO1.1)*
2. **Identify and analyse** the design objectives of distribution substation and **determine** their specifications and **develop** single line diagram. *(LO2.1, 2.2)*
3. **Apply** data information analysis techniques to **conclude** the energy performance of the plant and conduct the energy audit of an existing electrical installations and **analyse** its performance *(LO3.1, 3.2, 3.3)*
4. **Determine** the design objectives **to select** appropriate energy efficient technologies on techno-economic basis to **apply** in the given electrical installation. *(LO4.1, 4.2, 4.3, 4.4)*

CO-PO mapping table with correlation level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELBC710.1		3				3			3		3
EELBC710.2		3	3			3			3		3
EELBC710.3				3		3		3	3		3
EELBC710.4			3			3			3	3	3
Average		3	3	3		3		3	3	3	3

Text Books:

1. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000
2. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
3. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
4. Energy Management Handbook, by W.C. Turner, John Wiley and sons
5. Handbook on Energy Audits and Management‖, by Amit Kumar Tyagi, TERI
6. General Aspects of Energy Management and Energy Audit, Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE
7. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press
8. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
9. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.

Reference Books:

1. Medium Voltage technical guide, Basics for MV design according to IEC and IEEE standards, by Schneider Electric.
2. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010.
3. Energy Auditing Made Simple‖, by P. Balasubramanian, Seperation Engineers (P) Ltd.
4. Energy Management Principles, by C.B. Smith, Peragamon Press.
5. Energy Efficiency in Electric Utilities Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE.

Other Resources:

1. http://www.bee-india.nic.in/
2. NPTEL Video Course : NOC: Electrical Distribution System Analysis http://www.digimat.in/nptel/courses/video/108107112/L04.html

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Practical Exercises- 10 Marks
- Oral Test– 05 Marks
- Regularity and active participation - 05 Marks
- **Institute Substation Visit:** Students' visit to the Institute Power Distribution Substation to observe various Protection equipment, overall power flow in the system. It also includes visit to one of the LT panel room, one of the floor power distribution, UPS power panel. All students shall submit visit report in appropriate format as a part of the submission (05 marks)

END SEMESTER ASSESSMENT (Oral Examination) (25 Marks)

- Students will be appearing for Oral examination in front of both Internal and External examiners. Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LC	EELBC711	Applied Power Electronics Laboratory	01

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

Pre-requisite:

1. EEPCC407 Power Electronics
2. EELBC403 Power Electronics Laboratory

Program Outcomes addressed:

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

Course Objectives:

1. To provide hands-on skill-sets to design, model and implement the power electronics systems/ subsystems
2. To impart knowledge on practical aspects of power electronics converters design.
3. To impart the knowledge designing power converters for real life applications

Module	Details	Hrs
	Course Introduction Electrical engineering students should be adequately acquainted with the practical knowledge of Power Electronics converters, design, modelling and control implementation. Most of the engineering domains need some or other form of power converters. So knowledge of modelling, simulation, emulation, and H/W implementation is essential from Electrical engineering perspective. This course aims at imparting such knowledge through such tasks leading to the achievement of proficiency in Power Electronics domain	
01.	**Design of Power Electronics Converter Hardware**	**06**
	Learning Objective: ***To impart the skill of handling power electronics components and their use in various converters with modelling and closed loop control implementation as a team***.	
	Theme for conducting experiment/simulation: **1.** Implementation of a Buck or Boost or Buck-Boost DC-DC converter (any one converter) and its auxiliary circuits. Model and design of feed-back compensator for closed- loop control of the selected DC-DC converter fed from suitable energy source (any one converter) ***Learning Outcomes:*** *A learner will be able to* *LO 1.1:* Collaboratively design / implement hardware of DC –DC Converter to analyze it steady state / transient operations, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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) **2.** Implement a single-phase bridge inverter for an AC load. Model and design a feed-back compensator for a single-phase bridge inverter	

	Learning Outcomes: *A learner will be able to* *LO 1.2:* Collaboratively design / implement hardware of DC–AC Converter to analyze it steady state / transient operations, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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) **3.** Model and design a feedback compensator for a flyback or a suitable converter (SMPS) for auxiliary supply requirement/for LED lighting system / or any other application. Implement any power electronic converter for a specific application. ***Learning Outcomes:*** *A learner will be able to* *LO 1.3:* Collaboratively design / implement hardware/ simulate SMPS for a specific selected application, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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.	**Design of Power Electronics Converter Control (Programming)**	**08**
	Learning Objective: ***To develop skill to program / code the control algorithms for power electronics converters as a team***	
	Theme for conducting experiment: **4.** Implement single phase or three phase SPWM technique for control of bridge inverter for an AC load. ***Learning Outcomes:*** *A learner will be able to* *LO 2.1:* 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, 8.1.1, 8.1.2, 11.3.1, 11.3.2) **5.** Implementation of microcontroller / DSP code for voltage mode control (VMC) of DC-DC converter. Implementation of microcontroller / DSP code for current mode control (CMC) of DC-DC converter ***Learning Outcomes:*** *A learner will be able to* *LO 2.2:* Demonstrate the ability to design, develop, and implement microcontroller/ DSP programs for a given converter using appropriate software platforms, instructions, and programming techniques to meet technical and operational requirements for the closed loop control 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) **6.** Implementation of microcontroller / DSP code for VMC/ CMC of an inverter. Implementation of microcontroller / DSP code for v/f control of induction motor / any other drive application ***Learning Outcomes:*** *A learner will be able to*	

	LO 2.3: Demonstrate the ability to design, develop, and implement microcontroller/ DSP programs for a given converter using appropriate software platforms, instructions, and programming techniques to meet technical and operational requirements for the closed loop control 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)	
03.	**Design of Auxiliary Systems for Power Electronics Applications**	**06**
	Learning Objective: ***To acquire skill to design, implement simulate the auxiliary subsystems, protection and safety in the power electronics applications.***	
	Theme for conducting experiment: **7.** Design of Gate driver circuits for different power semi-conductor switches (Si devices or Wide band gap devices like SiC or GaN etc.) **8.** Design of snubber circuit and analysing its impact on the operation of switch used in PE converter or inverter **9.** Design of heat sink for a PE converter and verify its thermal performance. **10.** Design AC/DC voltage and Current Sensing (isolated/ or non-isolated) circuit for feedback control of a PE converter **11.** Design of over current / short circuit protection system for any PE converter ***Learning Outcomes:*** *A learner will be able to* *LO 3.1:* Design, implement/ simulate and test the power electronic subsystems using suitable platforms, execute experiments, assess performance, and correlate results with expectations. (P.I.- 2.1.2, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2, P.I.- 8.1.1, P.I.-11.3.1, P.I.-11.2.2)	
	Minimum 2 experiments from each module and Industrial visit	

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
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
4.1.1	Define a problem, its scope and importance for purposes of investigation
4.1.4	Establish a relationship between measured data and underlying physical principles
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
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.
8.1.1	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 power electronics components and their assembly into a particular power topologies using technical literature *(LO1.1, LO1.2, LO1.3).*
2. Apply programming skill to implement control algorithms using suitable software tool for a given power converter *(LO2.1, LO2.2, LO2.3).*
3. Integrate and interface components and subsystems used in power electronics applications. *(LO 3.1).*

CO-PO mapping table with correlation level:

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			3
EELC506.3		3		3	3			3			
Average		3		3	3			3			3

Text Books:

1. 1. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi. 2. L. Umanand, Bhatt, "Design of Magnetic Components for Switched Mode Power Converters", John Wiley & Sons

Other Resources:

1. 1. NPTEL course: Design of Power Electronic Converters, Prof. Shabari Nath, IIT Guwahati.
   2. NPTEL course: Advanced Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee

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 power electronics domain. 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
MJP	MJP701	Major Project-A	02

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 and Collaborative Teamwork
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-Long learning

Course Objectives

1. To motivate students to review the knowledge and skills they acquired during their program.
2. To ensure students can analyze a specific problem or issue, and they can demonstrate proficiency in project design, research methods application, data collection and analysis, and results presentation.
3. To foster self-learning and research skills.

Course Outcomes:

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

1. Identify and define a problem of societal or research relevance through a comprehensive literature review and a detailed problem analysis.
2. Apply appropriate engineering principles, analytical methods, and modern tools to design feasible and effective solutions for the identified problem.
3. Conduct investigations using suitable research methodologies, data collection, and analysis techniques to validate the proposed solution.
4. Evaluate the proposed solution considering societal, environmental, and ethical aspects to ensure sustainable engineering practices.
5. Demonstrate effective teamwork, project management, and communication skills in preparing and presenting project outcomes.
6. Engage in self-directed learning and continuous improvement to enhance technical competence and professional growth.

A. Guidelines for the Major Project-A

Guidelines

1. Project Topic Selection and Allocation

- Towards the end of Semester VI, students will be introduced to potential project domains and problem areas.
- Project topics must be finalized in consultation with the guide, ensuring technical feasibility and alignment with the guide's domain expertise.

- Students should refer to recent research papers (preferably from IEEE, Elsevier, ACM, or similar sources) not older than three years.
- Students are encouraged to propose original ideas, including problem statements inspired by Digital India initiatives, Smart India Hackathon (SIH), and other innovation platforms.

Criteria for Topic Finalization:

- Novelty: The work should introduce new contributions or address clear gaps in existing systems.
- Technological Relevance: Use of current and emerging tools, platforms, methods, and technologies.
- Originality: Avoid repetition of projects undertaken in the past three years.
- Product Orientation (Preferred): Solutions that can evolve into a deployable product or prototype.

Project Team & Execution:

- Each group must consist of 3–4 students (within the same or across departments).
- Projects may be executed internally or in collaboration with industry, research organizations, or external agencies.
- Guides will be allotted to monitor progress, review weekly work, and maintain attendance and log records.
- Topic proposals will be reviewed domain-wise, and final approval will be given by the HoD and the project coordination committee.

2. Project Progress Monitoring

- Each department shall constitute a Project Progress Monitoring Committee.
- Minimum two formal progress presentations must be conducted during the semester.
- Internal guides may coordinate with industry/external partners for off-campus project supervision if required.

3. Project Report Format

The final report should follow the institute guidelines and include:

1. Abstract
2. Introduction
3. Literature Review / Existing System
4. Research Gap / Limitations
5. Problem Statement and Objectives
6. Proposed System
    - Analysis / Algorithm / Framework
    - Design Methodology
7. Experimental Setup
    - Input Data / Dataset Details
    - Software and Hardware Specifications
    - Evaluation Parameters
8. Results and Discussion
9. Conclusion and Future Scope
10. References
11. Appendices (if applicable: Certificates, Publications, etc.)

Students are encouraged to complete relevant certification courses that support the technical requirements of their project.

B. In-Semester Continuous Assessment (Evaluation)

Total Marks: 50 (Semester VII)

Component	Description	Marks
Topic Approval Presentation	Evaluation by Project Monitoring Committee	10
Mid-Semester Progress Presentation	Demonstration of progress in methodology and implementation	15
Final Report & Presentation	Quality of report, implementation, teamwork, and final demonstration	20
Regularity and active participation	Consistent attendance, timely submission of weekly progress logs, proactive involvement in group discussions, task ownership, and meaningful contribution to project development throughout the semester.	05

Quality Evaluation Parameters

- Relevance and quality of the problem selected
- Clarity in problem definition, objectives, and scope
- Originality and relevance to current industry/research trends
- Quality of system design, methodology, and implementation
- Clarity, organization, and technical depth of the report
- Effectiveness of oral presentation
- Individual contribution and teamwork

Course Type	Course Code	Course Name	Credits
HSS	HSS703	Financial Planning	02

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO6: The Engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. Develop a foundational understanding of financial principles and their relevance to personal financial planning
2. Enhance analytical skills to assess financial situations and propose effective solutions.
3. Acquire practical financial management skills through budgeting, investment analysis, and debt management
4. Foster ethical and responsible financial behaviour in alignment with professional standards and societal values

Module	Details
01.	**Setting Financial goals, Budgeting & cash flow management** Understanding financial goals: short, medium, long-term, and setting them using the SMART criteria, Introduction to budgeting: covering income, expenses, savings, and investments, Budgeting techniques: zero-based budgeting, envelope system, and the 50/30/20 rule, Cash flow management strategies for maintaining financial stability.
02.	**Saving Strategies & Investments, Borrowing & Credits** Importance of saving and investing for financial growth, Introduction to different types of savings accounts and investment options, Understanding the risk-return tradeoff in investing, Diversification and asset allocation strategies, Responsible borrowing practices and managing debt, Credit management: credit scores, types of credit, and building good credit history.
03.	**Risk Management** Concept of financial risk and its implications, Types of financial risks: market risk, inflation risk, interest rate risk, credit risk, Introduction to insurance: types of insurance (life, health, property, auto), coverage options, Importance of emergency fund and risk mitigation strategies Evaluating risk tolerance and creating a risk management plan
04.	**Income tax Fundamentals** Basics of income tax: taxable income, tax deductions, tax credits, Understanding tax brackets and marginal tax rates, Types of taxes: income tax, payroll tax, capital gains tax, Filing tax returns: forms, deadlines, filing options, Tax-saving strategies: deductions, credits, retirement accounts
05.	**Waste management & recycling** Solid Waste Management: Collection, Treatment, Disposal, Recycling Processes and Technologies, E-waste Management and Hazardous Waste Handling, Circular Economy Principles, Waste Reduction Strategies: Source Reduction, Reuse, Repair

06.	**Environmental Impact Assessment** Introduction to Environmental Impact Assessment (EIA), EIA Process: Screening, Scoping, Impact Assessment, Mitigation, Monitoring, Methods and Tools for Impact Assessment: GIS, LCA, Risk Assessment, Case Studies of EIA in Various Sectors: Infrastructure, Energy, Mining, Construction, Role of Stakeholders in EIA Process
Total no. of hours: **30**	

Course Outcomes:

1. Demonstrate a comprehensive understanding of financial concepts
2. Analyze complex financial scenarios, identify financial challenges, and propose effective strategies to achieve financial goals.
3. Apply financial planning principles and techniques to develop personalized financial plans aligned with individual goals and circumstances.
4. Utilize financial tools, software applications, and online resources proficiently
5. Adhere to ethical standards and professional codes of conduct in financial decision-making
6. Recognize the societal impact of financial decisions and promote responsible financial behavior

Text Books :

1. Personal Finance by Jeff Madura and Hardeep Rai, Pearson Education
2. Financial Management: Principles and Applications, by Sheridan Titman, Arthur J. Keown, and John D. Martin, Pearson Education
3. Project Management: The Managerial Process, by Erik W. Larson and Clifford F. Gray, McGraw-Hill Education

Reference Books :

1. The Total Money Makeover: A Proven Plan for Financial Fitness, by Dave Ramsey, Thomas Nelson
2. Investing 101: From Stocks and Bonds to ETFs and IPOs, an Essential Primer on Building a Profitable Portfolio, by Michele Cagan , Adams Media
3. Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk, by Steve L. Allen (Publisher: Wiley)

Other Resources:

1. NPTEL Course: Behavioral And Personal Finance, By Prof. Abhijeet Chandra, Vinod Gupta School of Management, IIT Kharagpur :-Web link- https://onlinecourses.nptel.ac.in/noc24_mg07/preview
2. NPTEL Course: Financial Management, By CA Amita Bissa, Jai Narain Vyas University, Jodhpur:- Web link- https://onlinecourses.swayam2.ac.in/cec20_mg05/preview

Course Type	Course Code	Course Name	Credits
OEC	OEC8021	Project Management	03

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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO9: Communication
6. PO10: Project Management and Finance
7. PO11: Life-long learning

Course Objectives:

1. To familiarize students with fundamental project management concepts, frameworks, tools, and standard terminology relevant to engineering projects.
2. To enable students to analyze project requirements and apply systematic project selection techniques and portfolio management approaches for informed decision-making.
3. To enable students to plan projects effectively by developing work breakdown structures, schedules, budgets, and comprehensive risk management plans.
4. To equip students to monitor and control project progress using quantitative performance measurement techniques, including Earned Value Management.
5. To evolve students' leadership, communication, ethical awareness, and technical documentation skills necessary for effective project execution and formal project closure.

Module	Detailed Contents	Hrs
	Course Introduction In today's technology-driven and highly competitive engineering environment, effective project management has become critical for delivering complex projects within defined time, cost, quality, and resource constraints. Rapid technological advancements, multidisciplinary teams, and increased stakeholder expectations demand a structured approach to planning, execution, monitoring, and control of projects. This course provides students with a comprehensive understanding of project management principles, practices, and tools essential for managing engineering projects successfully. It covers key areas such as project selection and feasibility analysis, scope definition, scheduling techniques, cost and quality management, risk assessment, and performance monitoring using methods such as Earned Value Management. The course also addresses leadership, communication, and ethical considerations, enabling students to manage projects systematically in professional and industry-oriented environments.	**01**
01.	**Fundamentals of Project Management** **Contents:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI).	**4-6**
02.	**Project Selection, Initiation, and Feasibility Analysis** **Contents:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6-8
03.	**Project Planning and Scheduling Techniques** **Contents:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	**7-9**
04.	**Planning Project and Risk Management** **Contents:** Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan, Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks.	**6-8**
	Project Monitoring, Control, and Contracting	**6-8**

05.	**Contents:** Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit. Project Contracting, Project procurement management, contracting and outsourcing.	
06.	**Project Leadership, Closure and Documentation**	**4-6**
	Contents: Introduction to project leadership, ethics in projects, Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lesson learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
	Course Conclusion: Upon completion of the Project Management course, students will be able to systematically plan, manage, monitor, and close engineering projects using established project management principles and tools. They will demonstrate the ability to work effectively in teams, manage risks and stakeholders, make informed managerial decisions, and document lessons learned. The course prepares students to take on professional roles that require project coordination, leadership, and ethical responsibility in real-world engineering and organizational environments.	**01**
	Total	**45**

Course Outcomes: A learner will be able to-

1. Apply engineering fundamentals to interpret project management concepts, project life cycle phases, stakeholder roles, and organizational structures required for systematic project execution.
2. Analyze and evaluate project proposals using structured selection and feasibility techniques, identify tasks and resources for project initiation, assess economic viability, and apply engineering principles to understand team development and dynamics.
3. Design and develop comprehensive project plans using work breakdown structures, cost estimation, and scheduling techniques, apply modern project management tools to optimize time and resource utilization, and evaluate project plans based on economic and financial considerations.
4. Apply project planning, communication, and risk management techniques to allocate and optimize resources, manage schedule uncertainties, engage stakeholders effectively, and analyze project risks to select appropriate response strategies for successful project execution.
5. Analyze, Monitor and control project performance using planning and execution parameters, applying quantitative measurement and modern project management tools, managing stakeholder communication and team coordination, and identifying procurement and contracting activities to ensure effective project execution.
6. Apply, demonstrate, and document project leadership and communication skills to execute project closure activities, manage project termination processes, ensure customer acceptance,

and prepare formal closure reports and lessons learned for professional growth and knowledge management.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC8021.1	3	-	-	-	-	-	-	-	-	-	-
CEPEC8021.2	3	3	-	-	-	-	-	-	-	3	-
CEPEC8021.3	-	-	3	-	3	-	-	-	-	3	-
CEPEC8021.4	-	3	-	-	-	-	-	-	3	3	-
CEPEC8021.5	-	3	-	-	3	-	-	-	-	3	-
CEPEC8021.6	3	-	-	-	-	-	-	-	3	-	3
Average	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**3**

Text Books:

1. Project Management: A Managerial Approach, Meredith, J. R. and Mantel, S. J. Jr., 2017, Wiley India, ISBN: 978-1-119-36911-7, 9th Edition.
2. Project Management: Planning, Scheduling, and Controlling, Chitkara, K. K., 2014, Tata McGraw-Hill Education, ISBN: 978-0-070-67713-9, 2nd Edition.
3. Project Management: The Managerial Process, Gray, C. F. and Larson, E. W., 2018, McGraw-Hill Education, ISBN: 978-1-259-66271-6, 7th Edition.
4. Project Management, Gopalan, M. R., 2014, Wiley India Pvt. Ltd., ISBN: 978-8126550807, 2nd Indian Edition.

Reference Books:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute, 2017, PMI Publications, ISBN: 978-1-62825-664-2, 6th Edition.
2. Successful Project Management, Gido, J. and Clements, J. P., 2018, Cengage Learning, ISBN: 978-1-337-10067-2, 6th Edition.
3. Project Management, Lock, D., 2014, Gower Publishing, ISBN: 978-1-409-46228-6, 10th Edition.

Other Resources:

1. NPTEL Course: Project Management by Prof. K. K. Aggarwal / Prof. S. C. Dutta, IIT Delhi Web Link – https://onlinecourses.nptel.ac.in
2. Project Management Institute (PMI), PMBOK® and Standards Repository, Online Resource Web Link – https://www.pmi.org
3. MIT OpenCourseWare, Project Management and Systems Engineering, Massachusetts Institute of Technology. Web Link – https://ocw.mit.edu
4. Coursera, Project Management Principles and Practices, University of California, Irvine Web Link – https://www.coursera.org

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

1. Assignment on live problems/case studies: 10 Marks
   (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.)
2. Technical Report Writing: 05 Marks
3. 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
OEC	OEC8022	Finance Management	03

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

Program Outcomes addressed:

1. PO1 : Engineering Knowledge
2. PO2 : Problem Analysis
3. PO10: Project Management & Finance

Course Objectives :

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Overview of Indian Financial System**	**5-7**
	Contents: Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
02.	**Concepts of Returns and Risks**	**6-8**
	Contents: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuit y Due; Continuous Compounding and Continuous Discounting	
03.	**Overview of Corporate Finance**	**9-11**
	Contents: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	

	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04.	**Capital Budgeting** **Contents:** Meaning and Importance of Capital Budgeting; Inputs forCapital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's10 Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10-12**
05.	**Sources of Finance** **Contents:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**5-7**
06.	**Dividend Policy** **Contents:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani- Miller Approach	**2-4**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8022.1	3	3	-	-	-	-	-	-	-	-	-
OEC8022.2	3	3	-	-	-	-	-	-	-	3	-
Average	**3**	**3**	-	-	-	-	-	-	-	**3**	-

References :

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC8023	Entrepreneurship Development and Management	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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO6: The Engineer & The world
3. PO8: Individual and team work
4. PO9: Communication
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the fundamental concepts of entrepreneurship and effective management of business enterprises.
2. To develop understanding of business planning, ownership structures, and legal aspects related to entrepreneurship.
3. To familiarize students with the Indian entrepreneurial environment, including MSMEs, government policies, and support institutions.
4. To encourage entrepreneurial thinking by highlighting innovation, sustainability, and problem-solving in small and medium enterprises.

Module	Detailed Contents	Hrs
	Course Introduction This course is designed to develop a clear understanding of entrepreneurship as a career option and as a driver of economic growth. It covers the fundamentals of starting, organizing, and managing new ventures with special reference to the Indian business environment. The course explains business planning, legal frameworks, financial management, and government support for entrepreneurs. Emphasis is given to MSMEs, innovation, and sustainable development. Through practical insights and case discussions, the course prepares learners to identify opportunities and manage entrepreneurial challenges effectively.	**01**
01.	**Overview of Entrepreneurship**	**05-07**
	Content: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	

02.	**Business Plans and Importance of Capital to Entrepreneurship**.	**06-08**
	Contents: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur. Entrepreneurship and Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	
03.	**Women and Social Entrepreneurship**	**08-10**
	Contents: Concept and evolution of women entrepreneurship in India. Role and importance of women entrepreneurs in economic and social development. Characteristics, strengths, and challenges faced by women entrepreneurs. Government policies, schemes, and institutional support for women entrepreneurship. Role of self-help groups (SHGs), NGOs, and microfinance institutions in promoting women-led enterprises. Case studies of successful women entrepreneurs. Concept, meaning, and scope of social entrepreneurship. Difference between social entrepreneurship and traditional entrepreneurship. Role of social entrepreneurs in addressing social, economic, and environmental issues. Models of social enterprises and sources of funding.	
04.	**Indian Environment for Entrepreneurship**	**07-09**
	Contents: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organizations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	
05.	**Effective Management of Business**	**04-06**
	Contents: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
06.	**Achieving Success In The Small Business**.	**04-06**
	Contents: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand entrepreneurship fundamentals and collaboratively present a basic business plan

using effective teamwork, analysis, and communication skills.

2. Interpret business planning, financing, legal, and operational aspects of entrepreneurship, demonstrating the ability to develop, evaluate, and present comprehensive business strategies.
3. Understand the principles of women and social entrepreneurship and associated support systems.
4. Comprehend MSME regulations, financial schemes, and government support systems, and present structured reports for informed decision-making.
5. Identify challenges faced by micro and small enterprises and develop practical solutions, collaboratively presenting integrated case studies and informed management decisions.
6. Understand the small business life cycle and growth strategies, and collaboratively present solutions to real world business challenges.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8023.1	2	-	-	-	-	-	-	3	3	-	-
OEC8023.2	2	-	-	-	-	-	-	-	3	3	-
OEC8023.3	2	-	-	-	-	3	-	3	-	-	3
OEC8023.4	2	-	-	-	-	3	-	-	3	-	-
OEC8023.5	2	-	-	-	-	-	-	3	3	-	-
OEC8023.6	2	-	-	-	-	-	-	3	3	-	-
Average	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**3**	**3**	**3**

Text Books :

1. Poornima Charantimath, Entrepreneurship Development – Small Business Enterprise, Pearson Education.
2. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education.
3. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House.

Reference Books :

1. T. N. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi.
2. Madhurima Lall & Shikha Sahai, Entrepreneurship, Excel Books.
3. C. N. Prasad, Small and Medium Enterprises in Global Perspective, New Century Publications, New Delhi,

Other Resources :

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8024	Human Resource Management	03

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

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Collaborative Teamwork
3. PO10: Project Management and Finance

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction to HR**	**4-6**
	Contents: - Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions - Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	
02.	**Organizational Behaviour (OB)**	**7-9**
	Contents: - Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues - Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness - Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior - Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);	

	- Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. - Case study	
03.	**Organizational Structure &Design** **Contents:** - Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. - Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. - Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**6-8**
04.	**Human resource Planning** **Contents:** - Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale - Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning - Training & Development: Identification of Training Needs, Training Methods	**5-7**
05.	**Emerging Trends in HR** **Contents:** - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	**6-8**
06.	**HR -MIS, Strategic HRM and Labor Laws & Industrial Relations** **Contents:** - Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries - Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals - Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**9-11**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

1. Understand the concepts, aspects, techniques and practices of the human resource management
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8024.1	-	-	-	-	-	-	3	3	-	3	-
OEC8024.2	-	-	-	-	-	-	3	3	-	3	-
OEC8024.3	-	-	-	-	-	-	3	3	-	3	-
OEC8024.4	-	-	-	-	-	-	3	3	-	-	-
Average	-	-	-	-	-	-	**3**	**3**	**-**	**3**	**-**

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC8025	Professional Ethics & Csr	03

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

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Professional Ethics and Business**	**3-5**
	Contents: The Nature of Business Ethics; Ethical, Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
02.	**Professional Ethics in the Marketplace, Professional Ethics and the Environment**	**8-10**
	Contents: - Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy - Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
03.	**Professional Ethics of Consumer Protection, Professional Ethics of Job Discrimination**	**6-8**
	Contents: - Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy - Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
04.	**Introduction to Corporate Social Responsibility**	**5-7**
	Contents: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	

05.	**Corporate Social Responsibility**	**8-10**
	Contents: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06.	**Corporate Social Responsibility in Globalizing India**	**7-9**
	Contents: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8025.1	-	-	-	-	-	3	3	-	-	3	-
OEC8025.2	-	-	-	-	-	3	3	-	-	3	-
OEC8025.3	-	-	-	-	-	3	3	-	-	-	-
OEC8025.4	-	-	-	-	-	3	3	-	-	3	-
Average	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC8026	Circular Economy	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

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: Lifelong Learning

Course Objectives:

1. To introduce the fundamentals and need for Circular Economy (CE)
2. To impart the knowledge about environmental and economic impacts of products.
3. To make learner understand circular materials and product strategies.
4. To impart the knowledge of CE business models in engineering industries.

Module	Detailed Contents	Hrs
	Course Introduction This course introduces the Circular Economy (CE) paradigm—a transformative approach that shifts from linear consumption to restorative and regenerative systems. By embracing CE principles, engineers can contribute to designing products, processes, and infrastructures that maximize resource efficiency, reduce waste, and promote economic, environmental, and social sustainability.	**01**
01.	**Introduction to Circular Economy**	**05-07**
	Content: Linear economy, Role of the Industrial revolution in Linear economy, Disadvantages of Linear economy, Replacing Linear by Circular economy, History and evolution of circular economy, Global CE initiatives (EU Circular Economy Action Plan, UN SDGs), Role of R's in circular economy, Value optimization, Design out waste, Renewable energy, A differential- Linear vs. Circular economy, Building a resilient economy, Role of engineers in CE	
02.	**Systems Thinking and Life Cycle Thinking**	**06-08**
	Contents: Systems Thinking in CE, Core principles of Systems Thinking in CE, Application in the Circular Economy	

	Concept of Loops, Circularity, Life Cycle Analysis(LCA), Importance of LCA, An efficient approach by Neptune Pumps, Case study-winnow solutions, Embodied energy and material flows, Input-output analysis in industrial systems	
03.	**Circular Design and Materials Engineering**	**07-09**
	Contents: Material recovery, waste reduction, Reducing negative externalities, Connecting Businesses and people for circularity, Butterfly diagram, Design for disassembly, modularity, repairability, Materials selection for durability and recyclability , Bio-based and regenerative materials, Eco-design principle	
04.	**Circular Business Models and Industrial Applications**	**07-09**
	Contents: Circular Business Models, Product-as-a-Service (PaaS), Reverse logistics, remanufacturing, and refurbishment, Industrial symbiosis and closed-loop systems, Digital technologies enabling CE (IoT, blockchain, AI)	
05.	**Waste Management and Resource Recovery**	**06-08**
	Contents: Circular waste hierarchy, Urban mining and e-waste recycling, Industrial and agricultural waste valorization, Waste-to-energy and bioconversion technologies	
06.	**Circular Economy Implementation and Policy**	**06-08**
	Contents: CE indicators and metrics (e.g., Circularity Gap Report), National and international CE policies, Corporate sustainability and ESG frameworks, Roadmaps and barriers to implementation	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learner will be able to

1. Analyze the need for Circular Economy (CE) and apply systems and life cycle thinking to engineering
2. Integrate CE in design and material selection
3. Analyse real-world industrial circular practices
4. Apply engineering approaches to waste minimization and resource recovery
5. Analyse policy, regulations, and corporate strategies and integrate CE into engineering practice

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8026.1	3	3	-	-	-	3	3	-	-	3	3
OEC8026.2	3	3	3	-	-	3	-	-	-	3	-
OEC8026.3	3	3	-	-	-	3	3	-	-	-	3

OEC8026.4	3	3	-	-	-	3	3	-	-	-	3
OEC8026.5	3	3	3	-	-	3	3	-	-	-	3
Average	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**3**

Text Books :

1. Circular Economy: Principles and Benefits, Ken Webster., First Edition 2017, Ellen MacArthur Foundation Publishing.
2. Product Design and Life Cycle Assessment, Ireneusz Zbicinski, Danuta Romanowska, Barbara Bednarowska, First Edition, 2021, Springer
3. Designing for the Circular Economy, Martin Charter, Ursula Tischner, First Edition, 2017 Routledge

Reference Books :

1. The Circular Economy: A User's Guide, Subramanian Senthilkannan Muthu, First Edition, 2020, Springer
2. Industrial Ecology and Circular Economy: Energy and Resource Efficiency in Industry, Yasemin Gursoy, Bilge Sener, First edition, 2021, Springer.
3. Cradle to Cradle: Remaking the Way We Make Things, William McDonough, Michael Braungart, First edition, 2002, North Point Press

Other Resources :

1. NPTEL Course: Sustainable Engineering Concepts and Life Cycle Analysis, Prof. Brajesh Kumar Dubey | IIT Kharagpur
   Web Link- https://onlinecourses.nptel.ac.in/noc24_ce61/preview
2. NPTEL Course: Linear to Circular Economy, Prof Shalini Goyal Bhalla, IIT Roorkee
   Web Link- https://onlinecourses.swayam2.ac.in/aic21_ge19/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC8027	IPR and Patenting	03

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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO5: Engineering Tool Usage
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO8: Individual and Collaborative Team work
7. PO9: Communication
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce students to the significance of Intellectual Property and its impact on innovation and professional growth.
2. To clarify the essential concepts and distinctions among patents, copyrights, trademarks, industrial designs, trade secrets, and GI.
3. To simplify statutory provisions and legal procedures so students can confidently interpret various IPR frameworks.
4. To guide students in applying practical steps for obtaining, managing, and safeguarding different IP rights.
5. To foster ethical reasoning, holistic professional judgement, and awareness of cyber laws relevant to IPR

Module	Details	Hrs.
	Course Introduction The course introduces students to the fundamental concepts, legal frameworks, procedures, and applications of Intellectual Property Rights (IPR). With rapid technological advancement, understanding how to protect innovations is essential for engineers. This course equips learners with the knowledge to identify different forms of intellectual property, file and maintain IP rights, and manage IP assets ethically and strategically. Students will also develop awareness of cyber laws as they relate to digital content and IP.	**01**
01.	**Introduction to IPR**	**7-9**
	Contents:	

	Concept of Property, Tangible and Intangible Property, Intellectual Property: Definition, Need & Importance, Types of IPR: Patents, Copyright, Trademark, GI, Trade Secrets, Industrial Design, Evolution of IP laws: Paris Convention, Berne Convention, WIPO creation, TRIPS, Indian IPR system: CGPDTM, Copyright Office, GI Registry, PVPFR Authority, Role of IPR in R&D, Innovation, and International Trade.	
02.	**Patents**	**8-10**
	Contents: Patent definition, objectives, values and advantages, Criteria of patentability: Novelty, Inventive Step, Industrial Application, Non-patentable inventions under Indian law, Types of Specifications: Provisional, Complete, Parts of a Patent: Title, Field, Background, Description, Drawings, Claims, Abstract, Filing procedure: Forms (1, 2, 3, 5, 9, 18, 26), Examination, FER, Grant, Renewal, PCT Filing, Priority Date, Patent Cooperation Treaty, Revocation, Opposition: Pre-Grant & Post-Grant, Prior art search: Keywords, Boolean operators, Databases (WIPO, USPTO, Google Patents)	
03.	**Trademarks, Industrial Designs and GI**	**8-10**
	Contents: Trademarks: Definition, Functions, Brand Value, Distinctiveness, Types of marks (word, device, shape, color), Registration process, challenges in non-conventional marks, Infringement, Passing off, Domain name disputes, well-known marks. Industrial Designs: Definition, Novelty, Originality, Registration process, Infringement and remedies. Geographical Indications (GI): Meaning & Importance, Registration of GI goods, Indian GI examples.	
04.	**Copyright, Trade Secrets & Emerging IP**	**7-9**
	Contents: Copyright: Meaning, Subject Matter, Economic and Moral Rights, Ownership, Transfer, Licensing, Fair dealing, infringement, remedies, Copyright in the digital era. Trade Secrets: Conditions for protection, Misappropriation, NDAs, employment contracts. Emerging IPR: Plant varieties, Integrated circuit layout designs, Undisclosed information, Digital content issues (streaming, snippet tax)	
05.	**Cyber Laws for Digital IP Protection**	**4-6**
	Contents: Cyber Laws: IT Act 2000**,** Cybercrimes: identity theft, phishing, e-commerce fraud**,** Digital signatures, data protection, privacy**,** International cyber law issues.	

06.	**IP Management, Documentation and Commercialization**.	**3-5**
	Contents: Managing IP: IP documentation, Letters of instruction, Joint collaboration agreements, NDA, Cease & Desist, Settlement memorandum, Assignment & Licensing, Technology Transfer (ToT), IP valuation basics.	
	Course Conclusion	**01**
	The course provides a comprehensive understanding of Intellectual Property Rights and their relevance in engineering, innovation, and global business. Learners gain practical insights into patent drafting, trademark and design registration, copyright compliance, and cyber law frameworks. By the end of the course, students are equipped with knowledge and skills necessary to create, protect, and manage intellectual assets responsibly.	
	Total	**45**

Course Outcomes: Learner will be able to -

1. Compare fundamental IPR concepts by classifying major IP types and outlining key elements of India's IPR policy.
2. Identify key elements of patent fundamentals by outlining patentability criteria, filing steps and prior-art search procedures.
3. Identify essential aspects of trademarks, industrial designs and GI by interpreting legal and registration documentation.
4. Apply copyright, trade-secret and emerging IP provisions by identifying protected subject matter and reviewing case documentation.
5. Analyze cyber laws for digital IP protection by examining cybercrimes, preparing structured reports and evaluating credible cybersecurity and data-privacy information.
6. Evaluate IP management practices by assessing key documentation and critically examining clauses in licensing and collaboration agreements.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8027.1	--	3	--	--	--	3	3	--	--	--	--
OEC8027.2	--	3	--	--	2	3	3	--	--	--	--
OEC8027.3	--	3	--	--	2	3	--	3	3	3	--
OEC8027.4	3	3	--	--	--	3	--	--	--	--	--
OEC8027.5	3	--	--	--	--	3	--	--	--	--	--
OEC8027.6	--	3	--	--	--	3	--	--	--	--	--
Average	**3**	**3**	**--**	**--**	**2**	**3**	**3**	**3**	**3**	**3**	**--**

Text Books :

1. D. E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents & Trade Secrets, Cengage Learning, 2012.
2. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, 2nd ed., McGraw-Hill Education, 2010.
3. P. Narayanan, Intellectual Property Law, 3rd ed., Eastern Law House, 2010.

Reference Books :

1. F. Ali, The Law of Patents, LexisNexis, 2017.
2. R. Stim, Patent, Copyright & Trademark, 17th ed., NOLO Press, 2019.
3. WIPO, WIPO Intellectual Property Handbook, World Intellectual Property Organization, 2020.
4. K. C. Kailasam and R. Vedaraman, Law of Trademarks and Passing Off, LexisNexis, 2013.

Other Resources :

1. NPTEL Course: Intellectual Property Rights and Competition Law
   Web link- https://onlinecourses.nptel.ac.in/noc25_mg132/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8028	Disaster Management and Mitigation Measures	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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Modern Tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO8: Individual and Collaborative Team Work
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce fundamental concepts of disasters and relevance of disaster studies in engineering practice.
2. To convey causes and impacts of natural, human-induced, and emerging disasters
3. To familiarize students with disaster management frameworks and governance by studying national institutions, policies and international disaster risk reduction frameworks
4. To introduce modern technologies, geospatial tools, and data-driven approaches used in disaster management for risk reduction.
5. To teach concepts of disaster response, financing, and recovery mechanisms by analysing relief operations, logistics, medical response, risk financing, and Build Back Better principles.
6. To guide students about mitigation, preparedness, and community resilience by emphasizing structural and non-structural mitigation and ethical responsibility of engineers.

Module	Details	Hrs
	Course Introduction Disaster Management and Mitigation Measures is an interdisciplinary course that equips engineering students with essential knowledge to understand, assess, and reduce the impacts of natural and human-induced disasters. The course introduces fundamental disaster concepts, global and Indian disaster trends, and the growing influence of climate change and extreme events on society and infrastructure. Emphasis is placed on the role of engineers in disaster risk reduction through safe design, planning, technology adoption, and resilient	**01**

	infrastructure development. Students gain insights into disaster preparedness, response, mitigation strategies, and emerging risks, enabling them to contribute effectively to sustainable development, community safety, and national resilience in an increasingly hazard-prone world.	
01.	**Foundations of Disaster Risk Science**	**06-08**
	Contents: Disaster Concepts & Impacts: Direct, indirect and cascading effects, Social, economic & environmental consequences, Disaster-induced development challenges. Risk & Hazard Assessment: Components of disaster risk, Hazard identification & vulnerability assessment, Multi-hazard environment. Climate Change & Emerging Risks: Heatwaves, drought intensification, extreme rainfall, Sea-level rise & coastal vulnerability, Urban heat islands. Indian Context, India's hazard zonation: seismic, cyclone, landslides, flood, drought, Disaster statistics & case studies	
02.	**Natural & Human-Induced Disasters**	**05-07**
	Contents: Natural Disasters: Geological: Earthquakes, Tsunamis, Volcanoes, Landslides, Hydro-meteorological: Flood, Flash Flood, Drought, Cyclones, Cloudburst, Climate-related: Heatwaves, extreme weather events. Human-Induced & Technological Disasters: Industrial accidents, Chemical disasters (Bhopal), Nuclear hazards (Fukushima), Fire hazards (urban & industrial) Transportation accidents (rail/road/air/maritime), Infrastructure failures (dams, bridges, tunnels), Cyber-disasters & critical infrastructure cyber threats.	
03.	**Disaster Management Frameworks, Policy & Governance**	**07-09**
	Contents: Disaster Management Principles: Disaster management cycle, prevention, preparedness, response, recovery. Indian Disaster Governance: NDMA, SDMA, DDMA, NIDM roles and frameworks, National & state policies. International Frameworks & Standards: Sendai Framework for Disaster Risk Reduction, UNDRR, Sphere Standards, Global Humanitarian Principles, ESG & resilience reporting.	
04.	**Technology, Tools & Geospatial Intelligence**	**07-09**
	Contents:	
	GIS, Remote Sensing & GPS Applications: Demand Assigned Access Hazard mapping, Flood/landslide susceptibility mapping, Satellite-based early warning Modern Technologies: Drones & UAVs for reconnaissance, Web GIS platforms AI/ML & Data Analytics: ML models for rainfall, cyclone, flood prediction, Computer vision for damage assessment Smart Disaster Technologies: IoT-based early warning systems, Digital twins for urban planning, Smartphone apps (GEM, IMD, NDMA tools.	
05.	**Financing, Response, Relief & Rehabilitation**	**06-08**

	Contents: Disaster Financing Mechanisms: Risk financing & risk transfer, Insurance models (crop, property, catastrophe bonds), Pradhan Mantri Fasal Bima Yojana & other Indian schemes. Response & Relief Operations: Search & Rescue by NDRF, SDRF, NGOs, armed forces, Logistics management & supply chain resilience, Medical triage & emergency health systems. Recovery, Rehabilitation & Build Back Better: Post-disaster needs assessment (PDNA), Reconstruction policies, Resilient infrastructure design, Community resilience & social inclusion.	
06.	**Preventive, Mitigation & Community-Based Approaches**	**06-08**
	Contents: Structural Mitigation: Seismic design, retrofitting, Cyclone shelters & bio-shields, Flood protection structures, Storm-water management. Non-Structural Mitigation: Policy intervention & awareness, Capacity building, Early warning & communication systems, Land-use planning/zoning. Community Based Disaster Risk Reduction: Role of community institutions, NGOs & volunteers, Risk communication models, Indigenous knowledge systems	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learners will be able to

1. Summarize disaster concepts and analyse impacts and risk components in multi-hazard environments.
2. Classify and evaluate natural, human-induced, and technological disasters with reference to Indian and global case studies.
3. Interpret disaster management policies, governance frameworks, and institutional roles at national and international levels.
4. Apply modern tools and technologies such as GIS, remote sensing, and data analytics for disaster risk reduction.
5. Formulate/Design mitigation, preparedness, and recovery strategies incorporating community participation, sustainability, and resilience principles.

CO-PO Mapping Table with Correlation Level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8028.1	3	3	-	-	-	-	-	-	-	-	-
OEC8028.2	3	-	-	-	-	3	-	-	-	-	-
OEC8028.3	-	3	-	-	-	-	3	-	-	-	-
OEC8028.4	-	-	-	-	3	3	-	-	-	-	-
OEC8028.5	-	-	3	-	-	3	3	-	-	-	-
Average	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**-**

Text Books:

1. D. P. Coppola, *Introduction to International Disaster Management*, 3rd ed. Oxford, U.K.: Butterworth-Heinemann (Elsevier), 2015.
2. R. Shaw, S. Srinivas, and A. Sharma, *Disaster Risk Reduction: Methods, Approaches and Practices*, Singapore: Springer, 2014.
3. P. Sammonds, T. Glade, and M. Bubeck, *Disaster Management and Mitigation: Early Warning Systems, Community Resilience and Sustainability*, London, U.K.: Springer, 2016.
4. D. Alexander, *Natural Disasters*, 2nd ed. Dordrecht, The Netherlands: Springer, 2000.
5. A. S. Arya, *Disaster Management: Institutions and Policies*, New Delhi, India: Gyan Publishing House, 2006.

Reference Books:

1. A. K. Jha, R. Duyne Barenstein, P. M. Phelps, D. Pittet, and S. Sena, Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters, Washington, DC, USA: World Bank, 2010.
2. United Nations Office for Disaster Risk Reduction (UNDRR), Sendai Framework for Disaster Risk Reduction 2015–2030, Geneva, Switzerland: United Nations, 2015.
3. D. Alexander, Principles of Emergency Planning and Management, Oxford, U.K.: Oxford University Press, 2002.
4. National Disaster Management Authority (NDMA), Government of India, National Disaster Management Plan, New Delhi, India, Latest Edition.
5. C. Emdad Haque and M. Q. Zaman, Disaster Risk Reduction: Methods, Approaches and Practices, New York, NY, USA: Springer, 2014.

Other Resources :

1. NPTEL: Satellite communication, Prof. Kalyan Kumar Bandyopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/117105131
2. NPTEL/SWAYAM: Climate Change — Science, Impacts & Extreme Events https://onlinecourses.nptel.ac.in/noc25_ce135/preview
3. UDEMY: Advances in Disaster Management: Principles and Practices https://www.udemy.com/share/10aBGu/
4. ISRO IIRS E-Learning: Geospatial Technology for Disaster Risk Reduction (GIS, RS & GPS) https://elearning.iirs.gov.in/courses/paper_05/default.htm
5. **NDMA, Government of India – Policies, Guidelines & SOPs** https://ndma.gov.in/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)

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

B. END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
OEC	OEC8029	Environmental Management	03

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

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction and Definition of Environment**	**9-11**
	Contents: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
02.	**Global Environmental concerns**	**6-8**
	Contents: Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
03.	**Concepts of Ecology**	**5-7**
	Contents: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
04.	**Environmental Management and Government Regulation**	**10-12**
	Contents: Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
05.	**Quality-Based Environmental Management and ISO 14000 Framework**	**5-7**
	Contents:	

	Total Quality Environmental Management, ISO-14000, EMS certification.	
06.	**Overview of Environmental and Industrial Legislations**	**2-4**
	Contents: General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8029.1	-	-	-	-	-	3	3	-	-	3	-
OEC8029.2	-	-	-	-	-	3	3	-	-	-	-
OEC8029.3	-	-	-	-	-	3	3	-	-	3	-
Average	-	-	-	-	-	**3**	**3**	-	-	**3**	-

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers
   London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance
   For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
MJP	MJP802	Major Project-B	04

A. Guidelines for the Major Project-B

1. Project Continuation

- The project initiated in Semester VII (Major Project – A) continues in Semester VIII.
- Project Objectives, Outcomes, and POs remain the same.

2. Focus for Semester VIII

- This phase emphasizes completion, optimization, testing, performance evaluation, and deployment (where applicable).
- Students should work toward:
  - Validation through experiments, benchmarking, or user trials
  - Technical documentation and dissemination (paper, poster, demonstration)

3. Research and Innovation Encouragement

- Teams are encouraged to:
  - Present papers in conferences/symposia/workshops
  - Participate in inter-college / national project competitions or hackathons
  - Submit project outcomes to innovation cells, incubation centres, etc.
- Such activities carry marks under In-Semester Continuous Assessment (CIA).

4. Project Execution and Supervision

- The guide continues to monitor weekly progress and maintain:
  - Work logs
  - Attendance
  - Contribution records
- The department's **Project Progress Monitoring Committee** shall evaluate **at least two** progress reviews during the semester**.**

5. Project Report (Final Submission)

The final project report must include:

- Revised/Final Abstract
- Literature Review (updated if needed)
- Final System Design, Implementation, and Architecture
- Experimental Setup and Evaluation Parameters
- Results with Comparative Analysis
- Discussion, Conclusion & Limitations
- Future Scope and Applications
- References (IEEE format preferred)
- Appendices (Certificates, Publications, Competition Participation**, etc.)**

B. In-Semester Continuous Assessment (CIA) — *Total: 50 Marks*

Component	Description	Marks
Progress Review Presentation I	Demonstration of implementation progress with clarity in design and execution	10
Progress Review Presentation II	Demonstration of testing, validation, and refinement; readiness for final deployment	10
Research / Innovation Activities	• Participation/winning in project competitions, hackathons, etc. • Technical paper writing/presentation/publication	05 10
Final Draft Report (Spiral/Soft Copy)	Quality of documentation, structure, clarity, proper referencing, and reflection of actual work	10
Regularity & Active Participation	Consistent attendance, timely submissions, teamwork, individual responsibility, and weekly log progress	05

C. End Semester Examination (ESE) — *Total: 50 Marks*

Examination by Internal + External Examiners

Component	Description	Marks
Project Demonstration / Prototype Performance	Functional correctness, performance, robustness, completeness of implementation	20
Oral Presentation and Defence	Clarity in explaining methodology, decisions, results, and the ability to answer technical questions	15
Project Report (Final Hard-Bound Submission)	Technical depth, coherence, experimental analysis quality, formatting standards, and completeness	10
Individual Contribution Assessment	Clear evidence of individual technical contribution and responsibility within the team	05

AC-01-Item No. 2.0, 2.4, 3.0 & 3.4 dated 29th April 2024
AC-03-Item No. 3 dated 22nd September 2025
AC-04-Item No. 3.1.4 dated 7th March 2026

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

&

Fourth Year B. Tech Syllabus

Prepared by: Board of Studies for Electrical Engineering

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

Effective from: 2026-27

Revision: R-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, we strive to nurture engineers who not only excel in their fields but also contribute meaningfully to society.

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

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

4. **Opportunities for Teachers in Innovation:** We recognize the pivotal role of our faculty in shaping the educational experience. Our curriculum provides ample opportunities for teachers to innovate in teaching-learning methodologies and evaluation techniques. Through continuous 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 future of engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

Dean of Academics Agnel Charities Fr. C. Rodrigues Institute of Technology, Vashi

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.

Contents

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	Digital Business Management
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	Disaster Management and Mitigation Measures
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
Final Year

Course Type	Course Code	Course Name	Credits
PCC	EEPCC712	Electrical Systems Design And Auditing	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
4. EEPCC510 Protection and Switchgear

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
6. PO10: Project management and finance
7. PO11: Life-long learning

Course Objectives:

1. To comprehend various electrical systems, drawings and comprehend their application in electrical projects
2. To comprehend design of distribution substation and selection/sizing of cable and other auxiliary systems
3. To study data information analysis techniques and electrical load management techniques to apply in Energy audit project.
4. To familiarize with energy performance assessment of electrical system and different energy efficient technologies to use in energy audit process

Module	Details	Hrs.
	Course Introduction This course focused on design of electrical distribution network which is primarily required for HT consumer. It includes design of power distribution substation, selection sizing of various equipment used in the substation including distribution transformer, UG cable/Busbar, DG, interior lighting system etc. It also includes energy auditing of an existing electrical installation and improving energy efficiency by using different energy efficiency technologies such as Variable frequency drive, energy efficient motors etc.	**01**
01.	**Electrical Systems and Electrical Projects:**	**07**

	Learning Objective/s: *To impart the knowledge of different electrical projects and types of electrical drawings used in electrical projects, as well as to familiarize with different power distribution system and their selection criteria*	
	Contents: Types of electrical Projects, Types of electrical system, Activities of electrical engineer in Electrical projects, different plans/ drawings in electrical system design, single line diagram, Standard symbols to use in SLD. Three line diagram and its comparison with SLD. Different types of power distribution system and its selection criteria, Concept of RMU (Ring Main Units) in distribution systems, Difference between RMUs and HT Switchgears	
	Self-Learning Topics: *NA.* ***Learning Outcomes:*** *A learner will be able to* *LO1.1 Apply electrical engineering concepts to understand different electrical power distribution systems and electrical drawings and (P.I.-1.4.1)* *LO1.2 Apply knowledge of electrical engineering to differentiate different standard symbols to use in a single line diagram and illustrate its function towards the protection of the public (P.I.-1.4.1, 6.1.1)* *LO1.3 Apply fundamental engineering to understand the role of an electrical engineer in various electrical projects (P.I.-1.3.1)*	
02.	**Design of Power Distribution Substation:**	**09**
	Learning Objective/s: *To teach the requirements of a given electrical distribution system and deliver the process of designing distribution substation.*	
	Contents: Distribution Substation: Need, Advantages, Selection of site for substation, review of components in the substation. Selection of voltage rating of the installation, Factors to be considered for sizing of distribution transformer, Selection and sizing of distribution transformer and its specifications. Step and touch potential calculations for earthing grid design, Substation earthing design, TT, TN and IT systems. Review of different switchgears used in distribution network, Selection of HT/LT switchgears, metering, switchboards and MCC, Metering and protection CT and PTs, Time Current Characteristics of protection switchgear, Utilization category of switchgear, coordination and discrimination, Type 2 Coordination.	
	Self-Learning Topics: Special type Transformers, Protection against Electric shocks and electrical fires**.**	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply electrical engineering concepts to understand different parameters to consider for selection and sizing of distribution transformer. (P.I.- 1.4.1)* *LO2.2 Apply knowledge of fundamental engineering to calculate the specifications of protection equipment and auxiliaries required in distribution substation as per the applicable standards. (P.I.- 1.3.1,6.2.1)*	

	LO2.3 Determine design objectives, functional requirements while designing any distribution substation referring to regulations and standards relevant to distribution substation. (P.I.-3.1.6, 6.2.1) *LO2.4 Reframe given electrical power distribution network into simplified single line diagram. (P.I.-2.2.1)* *LO2.5 Explore and synthesize electrical engineering requirements considering safety issues while designing earthing system for any distribution substation (P.I.-3.1.5, 6.2.1)*	
03.	**Selection / Sizing of Cable and Auxiliary system:** ***Learning Objective/s:*** *To teach the design of feeder installations of a given electrical distribution system considering its requirements and make familiarize with other auxiliaries of a distribution network.* **Contents:** Cables used in a distribution network, Types of cable installation, Selection and sizing of cables, specification of cables, Concept of Earth / Unearth Cables, cable management systems, sizing of conduits and Trunking, Busbar system: advantages Comparison of bus bars with cables, sizing of busbars. Basics of selection of emergency/backup supplies, UPS, DG Set, Preliminary design of interior lighting system. IS standards applicable in above designs ***Self-Learning Topics:*** Construction details of a cable used in Distribution network ***Learning Outcomes:*** *A learner will be able to* *LO3.1Apply fundamental engineering knowledge to understand different cable installation methods and de-rating factors to consider refer to IEE wiring regulations while designing underground cables for the given electrical installations (P.I.- 1.3.1, 6.2.1)* *LO3.2 Apply electrical engineering concepts to calculate the size of underground cable for a given electrical installations and specify them as per standards. (P.I.- 1.4.1,6.2.1)* *LO3.3 Determine design objectives, functional requirements for selection and sizing of underground cable and arrive at its specifications referring to regulations and standards relevant to cable installations. (P.I.-3.1.6, 6.2.1)* *LO3.4 Explore and synthesize engineering requirements considering safety issues while designing any cable installation system or Busbar system (P.I.-3.1.5)* *LO3.5 Apply electrical engineering knowledge to understand different emergency supply systems. (P.I.-1.3.1)* *LO3.6 Determine design objectives, functional requirements for the design of interior lighting system. (P.I.- 3.1.6)*	**07**
04.	**Load Management in Electrical System:** ***Learning Objective/s:*** *To teach different commercial electricity bill parameters and impart the process to optimize the system demand by applying load management techniques.* **Contents:** Electricity billing of Industrial/commercial consumer, Impact of ToD tariff towards electrical load management, Power factor improvement and its benefit, sizing and location of capacitor banks, Impact of PF improvement on optimizing Electricity bill. Individual compensation of Motor load and Self-excitation phenomenon and its mitigation, effects of harmonics on PF Improvement system, Solution to mitigate the effect of harmonics.	**09**

	Self-Learning Topics: NA ***Learning Outcomes:*** *A learner will be able to* *LO4.1 Apply electrical engineering knowledge to understand different terms used to calculate commercial electricity bill and its role towards the load management. (P.I.-1.4.1,11.3.1)* *LO4.2 Apply the electrical engineering knowledge to analyze the effect of power factor tariff and TOD tariff towards optimizing maximum demand of the system. (P.I.-1.4.1, 11.3.2)* *LO4.3 Identify the electrical engineering knowledge that applies to decide the location of capacitor banks in the given electrical installations and understand the problems associated with the installations. (P.I.-2.1.2)* *LO4.4 Identify the electrical engineering knowledge that applies to mitigate different problems associated with power factor improvement installations. (P.I.- 2.1.3)*	
05.	**Energy Efficient Technologies :** ***Learning Objective/s:*** *To deliver the knowledge of different energy efficient technologies and analyze its effectiveness towards achieving energy efficiency of a given electrical installation.*	**07**
	Contents: Energy Efficient Motor: How to specify the motor, reasons for inefficiency, necessity of EEM, construction of EEM, classification of Motors based on their efficiency, Motor retrofit program, Technical aspects of EEM. Variable Frequency Drive: Application of VFD based on the load, comparison of VFD with conventional control, energy saving potential case study, effect of VFD on Motor. Energy Efficient Lighting Design (EELD): Lighting Power Density, Installed Load Efficacy Ratio (ILER), ILER assessment, Electronic Ballast, Lighting control techniques, energy saving potential case study. Soft starters, Energy Efficient pump, Maximum Demand controllers, Automatic Power Factor Controllers, Energy Efficient Transformer, BLDC Motor (EC Motor).	
	Self-Learning Topics: Energy Management system (EMS) and Building Management System (BMS).	
	Learning Outcomes: *A learner will be able to* *LO5.1 Apply electrical engineering knowledge to differentiate various energy efficient technologies. .(P.I.-1.4.1)* *LO5.2 Apply fundamental engineering concepts to calculate the energy saving potential of different energy efficient technologies. (P.I.- 1..1.1, 6.3.2)* *LO5.3 Analyze the effectiveness of different energy efficient technologies to apply in a given electrical installations, on a techno-economic basis for the sustainable development. (P.I.-2.2.3, 6.3.2, 10.2.1)* *LO5.4 Compare and contrast different energy efficient technologies to select the best on the basis of technical and economic feasibility. (P.I.- 2.2.4, 6.3.2, 10.2.1)*	
06.	**Energy Audit:** ***Learning Objective/s:*** *To equip the knowledge of an energy audit and its various approaches towards improving energy efficiency and analyze energy performance of a given electrical installation.*	**04**

	Contents: Energy Audit: Definition-need, Types of energy audit, Energy Management (audit) approach understanding energy costs, Bench marking, Maximizing system efficiencies, optimizing input energy requirement, fuel and energy substitution. Energy Audit instruments. Defining monitoring and targeting. Elements of monitoring and Targeting. Data Information Analysis techniques for energy optimization.	
	Self-Learning Topics: Features of Energy Conservation Act-2001	
	A learner will be able to, *LO5.1 Apply fundamental engineering knowledge to interpret energy audit process, its need and types to apply in the industry (P.I.-1.3.1, 11.1.1)* *LO5.2 Identify objectives of energy optimization in the plant and implement energy management techniques for the sustainable development (P.I.-2.1.1, 6.3.3, 11.1.1)* *LO5.3 Identify and select appropriate measuring instruments to conduct effectively energy audit in the plant. (P.I.-2.2.2)* *LO5.4 To apply fundamental engineering concept to understand energy monitoring and targeting and data information analysis techniques. (P.I.. 1.3.1)* *LO5.5 To use appropriate data information analysis techniques to analyze the recorded energy data to interpret the energy performance of given electrical installation. (P.I.. 4.3.1)* *LO5.6 Represent data in a graphical form to facilitate analysis of the data, and drawing of conclusions (P.I.- 4.3.3)*	
	Course Conclusion The course will conclude with the process and design of electrical distribution network which includes, distribution transformer, UG cable and associated metering and protection systems. It also concludes with the importance of energy audit to analyze the energy performance of an electrical distribution network and its improvement using different energy efficient technologies.	**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 Mechanical engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.1	Articulate problem statements and identify objectives
2.1.3	Identify the mathematical, electrical engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub 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
2.2.4	Compare and contrast alternative solution processes to select the best process.
3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
3.1.6	Determine design objectives, functional requirements and arrive at specifications
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions

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

6.3.3 Describe management techniques for sustainable development

10.2.1 Analyze and select the most appropriate proposal based on economic and financial considerations.

11.1.1 Describe the rationale for the requirement for continuing professional development

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

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

Course Outcomes :

1. Apply electrical engineering knowledge to select suitable power-distribution systems, interpret electrical drawings, and explain the role of an electrical engineer in project execution. *(LO1.1, 1.2, 1.3)*
2. Design an electrical distribution substation for a given installation and develop its single-line diagram in accordance with relevant standards. *(LO2.1, 2.2, 2.3, 2.4, 2.5)*
3. Design underground cable systems, busbar arrangements, and interior lighting systems for specified electrical installations in compliance with applicable safety standards. *(LO3.1, 3.2, 3.3, 3.4, 3.5, 3.6)*
4. Students will be able to analyze commercial electricity bills to optimize demand and propose solutions for improving power factor performance. *(LO4.1, 4.2, 4.3, 4.4)*
5. Analyze energy-efficient technologies and evaluate their techno-economic and environmental feasibility to improve the energy performance of electrical installations. *(LO5.1, 5.2, 5.3, 5.4)*
6. Identify and apply appropriate energy monitoring and data analysis techniques to evaluate the energy performance of industrial installations as part of the energy audit process. *(LO6.1, 6.2, 6.3, 6.4, 6.5, 6.6)*

CO-PO mapping table with correlation level:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
EEPCC712.1	3					3					
EEPCC712.2	3	2	3			3					
EEPCC712.3	3		3			3					
EEPCC712.4	3	3		3		3					3
EEPCC712.5	3	3				3				3	
EEPCC712.6		3	3			3					3
Average	**3**	**2.75**	**3**	**3**		**3**				**3**	**3**

Text Books :

1. Handbook of Electrical Installation Practice, Fourth Edition, by Geofry Stokes, Blackwell Science
2. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000
3. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
4. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
5. Energy Management Handbook, by W.C. Turner, John Wiley and sons
6. Handbook on Energy Audits and Management‖, by Amit Kumar Tyagi, TERI

7. General Aspects of Energy Management and Energy Audit, Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE
8. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press
9. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
10. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.

Reference Books:

1. Medium Voltage technical guide, Basics for MV design according to IEC and IEEE standards, by Schneider Electric
2. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010
3. Energy Auditing Made Simple‖, by P. Balasubramanian, Seperation Engineers (P) Ltd
4. Energy Management Principles, by C.B. Smith, Peragamon Press
5. Energy Efficiency in Electric Utilities Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE

Web References:

1. http://www.bee-india.nic.in/
2. NPTEL Video Course: NOC: Electrical Distribution System Analysis http://www.digimat.in/nptel/courses/video/108107112/L04.html

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. **Continuous Assessment (20 Marks)**
   - 01 MCQ test: 05 Marks
   - 01 Class test: 05 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%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PE	PEC7051	Power System Operation 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. PCC303- Elements of Power System
2. PCC408- Power System Engineering
3. PCC510- Protection and Switchgear

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5-Modern tool usage
4. PO6: The Engineer and The World
5. PO11: Life-long learning

Course Objectives:

1. To study load flow analysis and solve load flow problem using different numerical techniques.
2. To impart knowledge on generator operating cost, incremental cost, constraints in operation, solve load scheduling and unit commitment problem.
3. To study operation of power system using load frequency control and voltage control.
4. To impart knowledge on dynamics of synchronous generator, power system stability and its analysis.
5. To understand concept of interchange of power and energy.

Module	Details	Hrs
	Course Introduction **Power scenario in Indian grid, National and Regional load dispatching centers**. Power system operation and control is a specialized course in electrical engineering that deals with load flow analysis to ensure a continuous supply of power under steady state condition, economic operation of generators, stable operation by balancing power generation with demand, maintaining optimal voltage and frequency levels, ensuring the power exchange for efficient operation of the grid. Maintaining security and complying with industry standards are vital aspects of power system operation and control, ensuring the safe and secure delivery of electricity. Hence, the fundamental concepts of this course are essential for power system engineers.	**01**
01.	**Load Flow Studies**	**09-10**
	Learning Objective: *To teach load flow analysis and solve load flow problem using different numerical techniques and simulate using modern tools.*	
	Contents Introduction, formation of Y bus using direct method, step by step method, Load flow problem, Load flow equation and methods of solution, Gauss-Seidel method, Newton-	

	Raphson method, Decoupled load flow method, Fast decoupled load flow method, Comparison of load flow methods (Numerical)	
	Self-Learning Topics: *Identify modern engineering tools for modeling and analysis of load flow problems*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply advanced mathematical techniques to model and solve load flow problems problems (PI-1.1.2)* *LO1.2: Apply electrical engineering concepts to solve engineering problems using load flow methods (PI-1.4.1)* *LO1.3: Identify engineering systems, variables, and parameters to solve the load flow problems using numerical techniques (PI-2.1.2)* *LO1.4: Compare and contrast alternative solution processes to select the best process for solving the problem using numerical techniques (PI-2.2.4)* *LO1.5: Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources to solve engineering problems(PI-5.1.1, 5.1.2)*	
02.	**Economic Operation of Power System**	**06-07**
	Learning Objective: *To impart knowledge on generator operating cost, incremental cost, constraints in operation, solve load scheduling and unit commitment problem.*	
	Contents: Optimal operation of generators in thermal power station, heat rate curve, input-output curve, IFC curves, optimum generation scheduling neglecting Transmission losses (coordinate equation), optimum generation scheduling considering transmission losses (Exact coordinate equation), Transmission loss formula, Bmn coefficient, optimal unit commitment (Numerical)	
	Self-Learning Topics: Nil	
	Learning Outcomes: *A learner will be able to* *LO2.1: Apply fundamental engineering concepts to solve optimum generation scheduling problems (PI-1.3.1)* *LO2.2: Apply Electrical engineering concepts to solve optimum generation scheduling problems (PI-1.4.1)* *LO2.3: Identify engineering systems, variables, and parameters to solve optimum generation scheduling problems, Understand the relationship between the technical, socio economic and environmental aspects of sustainability to solve for optimum generation scheduling (PI-2.1.2, 6.3.2)* *LO2.4:Identify the mathematical, engineering and other relevant knowledge to obtain transmission loss coefficient, Apply principles of preventive engineering and sustainable development for solving co-ordination equation (PI-2.1.3, 6.3.4)*	
03.	**Automatic Generation control**	**08-09**
	Learning Objective: *To impart knowledge on automatic generation control in power system using load frequency control*	
	Contents: Introduction, necessity of voltage and frequency regulation, Basic control loops in generator, Basics of speed governing mechanisms and modelling, thermal control, steam turbine, and power system transfer function, Load frequency control (single area), speed load characteristics, regulation of two generators in parallel. steady state and dynamic response, integration of economic dispatch control with LFC. Load frequency control of two area system, Composite block diagram (Numerical)	

	Learning Outcomes: *A learner will be able to* *LO3.1: Apply advanced mathematical techniques to model turbine speed governing system for thermal control (PI-1.2.1)* *LO3.2: Apply Electrical engineering concepts to solve load frequency control problems. (PI-1.4.1)* *LO3.3: Identify engineering systems, variables, and parameters to solve the problems of steady state and dynamic response of load frequency control of an isolated power system, Interpret codes, and standards relevant to load frequency and voltage control (PI- 2.1.2, 6.2.1)* *LO3.4: Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions to solve load frequency control problems, using principles of preventive engineering (PI-2.2.3, 6.3.4)*	
04.	**Power System Stability**	**09-10**
	Learning Objective: *To teach out of step falling of synchronous generator, different techniques for power system stability analysis using equal area criterion*	
	Contents: Introduction to stability, types of stability, Power angle curve, dynamics of synchronous machine, Swing equation, steady state stability, transient stability, analysing transient stability using the equal area criterion, some techniques for improving transient stability (Numerical)	
	Self-Learning Topics: *Identify modern engineering tools for modeling and analysis of stability*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply advanced mathematical techniques to model and solve problems on stability in power system (PI- 1.1.2)* *LO4.2: Apply Electrical engineering concepts to solve numerical on steady state stability problems. (PI-1.4.1)* *LO4.3: Identify engineering systems, variables, and parameters to solve the problems using swing equation for transient stability, Interpret codes, and standards relevant to stability (PI-2.1.2, 6.2.1)* *LO4.4: Identify existing processes/solution methods for solving the problem of transient stability, Apply principles of preventive engineering for stability of system (PI-2.2.3, 6.3.4)* *LO4.5: Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources to solve engineering problems (PI-5.1.1, 5.1.2)*	
05.	**Voltage Stability**	**07-08**
	Learning Objective: *To impart knowledge on the concepts of voltage stability using reactive power control.*	
	Contents: Introduction, Comparison of Angle and Voltage Stability, Reactive Power Flow and Voltage Collapse, Mathematical Formulation of Voltage Stability, Voltage Stability Analysis, Prevention of Voltage Collapse, Future Trends and Challenges.	
	Learning Outcomes: *A learner will be able to* *LO5.1: Apply advanced mathematical techniques to model and solve problems on voltage stability in power system (PI- 1.1.2)* *LO5.2: Apply Electrical engineering concepts to solve numerical on voltage stability problems. (PI-1.4.1)* *LO5.3: Identify engineering systems, variables, and parameters to solve the on voltage stability, Interpret codes, and standards relevant to stability (PI-2.1.2, 6.2.1)*	

	LO5.4: Identify existing processes/solution methods for solving the problem of voltage stability, Apply principles of preventive engineering for stability of system (PI-2.2.3, 6.3.4)	
06.	**Power system security and Interchange of power**	**04-05**
	Learning Objective/s: *To impart knowledge on interchange of power and energy between utilities*	
	Contents: **Power system security**: System state classification, security analysis, contingency analysis. **Interchange of power**: Interchange of power between interconnected utilities, types of interchange, capacity and diversity interchange, energy banking, power pools	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify engineering systems, variables, and parameters for security analysis and contingency analysis, Identify impacts of power and energy interchange activity for sustainable development (PI-2.1.2, 6.3.3)* *LO 6.2: Compare and contrast alternative solution processes to select the best process, Understand the relationship between the technical, socio economic and environmental dimensions of sustainability using security analysis and contingency analysis in power system (PI-2.2.4, 6.3.4)* *LO6.3: Recognize the need and keep current regarding new developments in power interchange schemes (PI-11.2.1, 11.2.2)*	
	Course Conclusion It involves the continuous, coordinated management of power generation and load to deliver electricity to consumers with uninterrupted supply, stable frequency, and acceptable voltage. This is achieved through real-time monitoring, automatic control systems like Load Frequency Control (LFC) and Automatic Voltage Regulators (AVR), and economic dispatch to balance generation with dynamic demand while minimizing costs and ensuring system reliability.	**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.
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
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
6.2.1	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
6.3.3	Describe management techniques for sustainability
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. Analyze load flow problems in power system using different numerical techniques *(LO1.1, LO1.2, LO1.3, LO1.4).*
2. Apply and analyze load scheduling and unit commitment problem for sustainable development. *(LO2.1, LO2.2, LO2.3, LO2.4)*
3. Analyze automatic generation control using load frequency control (*LO3.1, LO3.2, LO3.3, LO3.4)*
4. Identify and analyze power system stability and voltage stability *(LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4)*
5. Discuss the concept of interchange of power and energy between utilities *(LO6.1, LO6.2).*

CO-PO mapping table with correlation level:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
EEPEC7031.1	3	3			3						
EEPEC7031.2	3	3				3					
EEPEC7031.3	3	3				3					
EEPEC7031.4	3	3			3	3					
EEPEC7031.5		3				3					3
Average	**3**	**3**			**3**	**3**					**3**

Text Books :

1. Kothari D.P., Nagrath I.J., Modern power system Analysis, TMH publication, 4e, 2019.
2. Chakrabarti A, Halder S., Power System Analysis-Operation and Control, PHI
3. Allen Wood, Bruce F. Wollenberg, Power Generation operation and control, Willey India
4. B.R. Gupta, Power System Analysis and Design, S. Chand

Reference Books :

1. Hadi Saadat, Power System Analysis, TMH publications, 2e
2. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Ltd, New Delhi, 30th reprint,2007.
3. Soman S.A., Kharpade S.A., and Subha Pandit - Computer Methods for Large Power System Analysis, an object Oriented Approach, Kluwer Academic Publisher New York 2001.

Other Resources :

1. NPTEL Course: Power System Analysis, Prof. A.K. Sinha, IIT Kharagpur
2. NPTEL Course: Power System Engineering, By Prof. Debapriya Das, IIT Kharagpur
3. NPTEL Course: Power System Protection, By Prof. Ashok Kumar Pradhan, IIT Kharagpur

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Numerical Assignment/s (min 20 problems): 05 Marks
   - Class test based on above numerical assignment: 05 marks
   - Technical report writing: 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	EEPEC7032	Digital VLSI 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. ECMDM3013: Electronic Components and Circuits

Program Outcomes addressed:

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

Course Objectives:

1. To impart fundamental knowledge of MOSFET behaviour and its application in VLSI circuits.
2. To evaluate the performance metrics of CMOS inverters and basic gates such as NAND and NOR.
3. To design combinational and sequential circuits using various design styles and implement them through HDL coding for verification and testing.
4. To analyse the structure and operation of RAM and ROM arrays.

Module	Details	Hrs
	Course Introduction Digital VLSI Design is a specialized course focusing on the design and implementation of high-performance integrated circuits. Understanding MOSFET operation, CMOS logic behavior, and the construction of combinational and sequential circuits is crucial for creating efficient and reliable digital systems. The course also emphasizes Hardware Description Languages (HDL) for modeling, simulation, and verification of complex logic designs. The fundamental concepts of this course are essential for designing, implementing, and testing modern VLSI circuits.	**01**
01.	**Fundamentals of VLSI and MOS Devices**	**04-05**
	Learning Objective/s: *To impart knowledge of MOSFET operation and characteristics relevant to VLSI design*	
	Contents Role and scope of VLSI in modern electronics, Overview of VLSI Design Flow, Metal Oxide Semiconductor Structure, MOS under External Bias, Operation of MOS Transistor. Threshold voltage equation and energy band diagram of MOSFET, controlling of threshold voltage. MOSFET current-voltage characteristics, mathematical models.	
	Learning Outcomes: *A learner will be able to*	

	LO 1.1: Apply fundamental engineering concepts to understand the role and scope of VLSI in modern electronics and outline the complete VLSI design flow. (P.I.–1.3.1) *LO 1.2: Apply principles of semiconductor physics to comprehend the metal–oxide–semiconductor structure and analyze its behavior under external bias. (P.I.–1.4.1)* *LO 1.3: Identify suitable methods to derive current–voltage characteristics of MOSFET for circuit analysis (P.I.–2.2.3)* *LO 1.4: Develop the threshold-voltage equation and energy-band diagrams by combining semiconductor physics and engineering approximations. (PI 2.3.1)*	
02.	**Static CMOS Logic Design**	**09-10**
	Learning Objective: *To analyze and design CMOS inverters, NAND, NOR, and complex logic circuits with respect to various performance metrics.*	
	Contents: CMOS inverter: operation, static and dynamic characteristics, Noise margins, power–speed–robustness trade-offs, Design and analysis of basic gates: NAND, NOR, XOR, Sizing of transistors for logic gates, Simple combinational design examples using static CMOS.	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply advanced mathematical techniques to model a CMOS inverter and determine its static and dynamic characteristics. (P.I.-1.1.2)* *LO 2.2: Apply fundamental engineering concepts to identify the operation of CMOS Inverter, NAND and NOR gate (P.I.-1.3.1)* *LO 2.3: Identify basic concepts of CMOS Inverter and analyze all the basic performance metrics of VLSI design (Noise margin, Propagation delay, Power dissipation and Area.in static and dynamic state (P.I.- 2.1.3)* *LO 2.4: Identify and utilize relevant parameters to choose a proper transistor sizing for reliable CMOS logic gate operation. (PI-2.1.2)*	
03.	**Alternative Logic Styles & Combinational Circuits**	**05-06**
	Learning Objective: *To design, implement and verify combinational logic circuits using various MOS design styles.*	
	Contents: Motivation for alternatives to static CMOS, Pseudo-nMOS, complementary pass-transistor logic, Dynamic, Domino, and Zipper logic concepts, Design of common combinational blocks: Multiplexers, encoders/decoders, Full adder, ripple-carry adder, carry-look ahead adder, Simple array multiplier.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify key parameters, trade-offs, and performance considerations for different logic styles and combinational circuits (P.I-2.1.2)* *LO 3.2: Analyze the basic concepts of different design styles for combinational circuits leading to conclusions in terms of merits and limitations. (P.I-2.4.4)* *LO 3.3: Determine the design objectives and set specifications for the combinational circuit design. (P.I.-3.1.6)* *LO 3.4: Identify suitable criteria for evaluation of alternate design solutions using different styles for applications of digital design such as full adder, Decoder etc..(P.I-3.2.3)*	

	LO 3.5: Develop the ability to analyze alternative CMOS logic styles, design combinational circuits, and effectively present solutions in collaborative activities. (P.I.- 3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.2.1, PI 9.2.2)	
04.	**Sequential Circuits and Timing**	**06-07**
	Learning Objective: *To design, implement and verify sequential logic circuits with timing analysis.*	
	Contents: Latches and flip-flops: SR, D, JK, master-slave configurations, Edge-triggered design and setup/hold time concepts, Meta stability and clock skew basics, CMOS implementation styles for sequential elements, Simple finite state machine (FSM) design examples.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Identify key characteristics and design variables for sequential circuit analysis. (P.I-2.1.2)* *LO 4.2: Combine semiconductor physics and CMOS concepts to model latches, flip-flops, and simple FSMs for analyzing their static and dynamic behavior. (P.I-2.3.1)* *LO 4.3: Determine the design objectives and establish specifications for the design of sequential circuits. (P.I.-3.1.6)* *LO 4.4: Apply structured idea-generation techniques to create multiple alternative design solutions for sequential logic circuits. (P.I.- 3.2.1)* *LO 4.5: Develop the ability to analyze and design CMOS-based sequential circuits, including latches, flip-flops, and simple FSMs, and effectively present solutions in team settings. (P.I.- 3.1.6, PI 8.1.1, PI. 8.2.1, PI. 9.2.1, PI 9.2.2)*	
05.	**On-Chip Memory**	**05-06**
	Learning Objective: *To analyze the working of NAND and NOR based ROM array.*	
	Contents: ROM array-NAND and NOR based ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM, Peripheral Circuits, Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory.	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply core principles of engineering to classify semiconductor memories. (P.I-1.4.1)* *LO 5.2: Apply fundamental engineering concepts to solve the problems of volatile memories. (P.I-1.3.1)* *LO 5.3: Identify the mathematical approach that applies to NAND and NOR flash memory. (P.I-2.1.3)* *LO 5.4: Extract the understanding objectives and limitations of 6T SRAM / 3T DRAM (P.I-2.4.4)*	
06.	**HDL Modeling and Simulation for Digital Circuits**	**09-10**
	Learning Objective/s: *To develop HDL code to model and test combinational and sequential circuits..*	
	Contents:	

	Verilog/VHDL basics: syntax, modules, ports, signals, Data types, operators, and procedural statements, Combinational Circuit Modeling: Implement AND, OR, XOR, multiplexers, decoders, Sequential Circuit Modeling: Implement D, JK, SR, and master-slave flip-flops, Simulation and Verification: Run testbenches to verify functionality.	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify the relevant HDL constructs, data types, operators, and engineering knowledge required to model the given combinational and sequential circuits. (P.I-2.1.3).* *LO 6.2: Compare alternative HDL coding styles and select appropriate modeling methods for a given design problem. (P.I.–2.2.4, P.I.–5.1.1).* *LO 6.3: Identify and correct syntax or functional errors in HDL code using simulation tools and waveform analysis. (P.I.–2.4.3, P.I.–5.1.2).*	
	Course Conclusion The course concludes with a comprehensive understanding of MOSFET operation, CMOS logic design, and the implementation of combinational and sequential circuits using various design methodologies. Additionally, the integration of Hardware Description Languages (HDL) for modeling, simulation, and verification enables learners to design and test complex digital systems for real-world VLSI applications.	**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.
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.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
3.2.3	Identify suitable criteria for evaluation of alternate 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
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non technical audiences

Course Outcomes: Learner will be able to

1. Comprehend MOSFET operation and characteristics within the context of VLSI design. *(LO 1.1, LO 1.2, LO1.3, LO1.4)*
2. Analyze and design basic CMOS circuits such as Inverters, NAND, and NOR gates, considering their performance and layouts. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Analyze and design CMOS combinational and sequential circuits, using various design styles, including timing behavior. (*LO 3.1, LO 3.2, LO3.3, LO3.4, LO 3.5, LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5)*
4. Analyze the performance and limitations of semiconductor memories used in VLSI design. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Develop HDL codes for combinational and sequential circuits with test bench and perform functional simulation using computer aided design tools. *(LO6.1, LO6.2, LO6.3)*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7032.1	3	3									
EEPEC7032.2	3	3									
EEPEC7032.3		3	3					3	3		
EEPEC7032.4	3	3									
EEPEC7032.5		3			3						
Average	**3**	**3**	**3**		**3**			**3**	**3**		

Text Books :

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2012
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.
3. Neil H.E Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design-A Circuits and Systems Perspective", 3 rd Edn, Pearson, 2009
4. Dr. S. Ramachandran, "Digital VLSI Systems Design", Springer, 2007.

Reference Books :

1. M. Morris Mano , "Digital Design", 3rd edition
2. N H E Weste & K, "Principles of CMOS VLSI design"
3. Wayne Wolf, "Modern VLSI Design: System on Silicon"
4. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, Student Edition, 2013.
5. Mead & Convey, "Introduction to VLSI Design",BS Publications, 2010.

Other Resources :

1. NPTEL Course: VLSI Design Verification and Test, By Dr.Santosh Biswas, Prof. Jatindra Deka, IIT Guwahati. Web link- https://nptel.ac.in/courses/106103016

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Simulations – 05 Marks
   - Class test: 05 marks
   - Activity based study-Team-Pair-Solo : 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	EEPEC7033	Automation and Control	03

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

Pre-requisite :

1. EEPCC406: Control System
2. EELBC404: Control System Laboratory
3. EEPCC509: Electrical Machines
4. EELBC507: Electrical Machines Laboratory
5. EESBL603: Industrial Automation Laboratory

Program Outcomes addressed :

1. PO1: Engineering Knowledge.
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer and The World
7. PO8: Individual and Collaborative Team Work
8. PO9: Communication
9. PO10: Project Management and Finance
10. PO11: Life Long Learning

Course Objectives :

1. To introduce basic principles of automation in production systems.
2. To explore production economics, costs, and investment analysis.
3. To comprehend automated flow lines and material handling systems.
4. To understand automated assembly systems and their components.
5. To impart knowledge on PLC architecture and programming methods.
6. To learn SCADA, DCS, HMI, and industrial communication protocols.

Module	Details	Hrs.
	Course Introduction This course offers a comprehensive overview of **automation and control systems** in modern manufacturing, focusing on key areas such as **automation strategies**, **production economics**, and **system design**. It covers essential topics like **automated flow lines**, **material handling**, and **assembly systems**, along with in-depth study of **control systems** including **PLCs**, **SCADA**, and **DCS**. Students will learn **PLC programming**, use of **timers, counters, PID controllers**, and gain exposure to **industrial communication protocols** like **PROFIBUS** and **HART**. The course also emphasizes the role of **HMIs** in system	**01**

	visualization and control, providing the skills needed to design, control, and optimize intelligent automated production systems.	
01.	**Basics Concepts of Automation** ***Learning Objective: To impart knowledge on automation principles and levels in production systems and analyze production economics through cost, investment, and efficiency evaluation.***	**4-6**
	Contents: Automation in Production System, Principles and Strategies of Automation, Review of elements of an Automated System and Levels of Automations, Advanced Automation Functions. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process.	
	Self-Learning Topics: Break Even Analysis	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to perform economic assessment of production automation. (PI-1.1.1)* *LO 1.2: Apply fundamental concepts of Automation and its levels to solve engineering problems. (PI-1.3.1)* *LO 1.3: Identify and define economic parameters affecting manufacturing systems. (I-2.1.2)* *LO 1.4: Identify the mathematical and other relevant knowledge to perform economic evaluation and analysis of automation in production systems. (PI-2.1.3)*	
02.	**Automated Production Lines** ***Learning Objective: To comprehend and analyze automated flow lines, transport mechanisms, buffer storage, and control functions for efficient machining automation and system design.***	**06-08**
	Contents: Automated Flow lines, Methods of Work-part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.	
	Self-Learning Topics: Case study on computer simulation of automated flow line	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply mathematical and engineering fundamentals to model cycle time, throughput, and buffer behavior in automated flow lines. (PI-1.1.1)* *LO 2.2: Apply fundamental engineering knowledge to understand work-part transport, transfer mechanisms, and automated machining systems. (PI-1.3.1)* *LO 2.3: Identify and formulate problems related to bottlenecks, blocking, starvation, and WIP in automated production systems. (PI-2.3.2)* *LO 2.4: Analyze flow lines with/without storage using models and simulations to draw valid performance conclusions. (PI-2.4.4)* *LO 2.5: Identify and use modern tools such as CAD, CNC simulators, and production line simulation software to model automated systems. (PI-5.1.1)* *LO 2.6: Validate and interpret results from computer simulation of automated flow lines, considering tool assumptions and limitations. (PI-5.3.2)*	
03.	**Material handling and Identification Technologies**	**05-07**
	***Learning Objective:** To understand and analyze automated flow-line systems—including work-part transport methods, transfer mechanisms, buffer storage, and machining automation—and evaluate their performance using analytical models and computer simulation to recommend effective design and optimization solutions.*	

	Contents: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc. **Automated Assembly Systems:** Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multistation Assembly Machines, Analysis of a Single Station Assembly Machine.	
	Self-Learning Topics: Case Studies of Automated Manufacturing Lines	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply mathematical, engineering, and manufacturing fundamentals to model and design production systems, flow lines, material handling systems, and automated assembly/machining systems. (PIs-1.1.1, 1.3.1, 2.1.2, 2.3.1)* *LO 3.2: Identify, formulate, and analyze bottlenecks, WIP, storage, material flow, and assembly cycle issues using analytical and simulation-based methods to draw valid conclusions. (PIs-2.1.3, 2.4.2, 4.3.2, 4.3.4)* *LO 3.3: Design and refine material handling, storage, and automated assembly systems—including conveyors, AGVs, AS/RS, part-feeding systems, and multi-station layouts. (PIs-3.2.3, 3.3.1)* *LO 3.4: Use modern tools to model, simulate, and validate flow lines, material handling systems, AS/RS, AGVs, and assembly machines while considering tool limitations and assumptions. (PIs-5.1.1, 5.3.2)* *LO 3.5: Evaluate automated material handling and assembly systems in terms of safety, ergonomics, sustainability, environmental, social, and economic impact. (PIs-6.1.1, 6.3.2)* *LO 3.6-Work effectively in diverse teams to analyze, design, integrate, and communicate solutions for conveyors, AGVs, AS/RS, automated assembly systems, and identification technologies (RFID, barcode). (PIs-8.2.1, 8.3.1, 9.1.2, 9.2.2, 10.3.1, 10.3.2)*	
04.	**Introduction to Programmable Logic Controllers** ***Learning Objectives:*** *To impart knowledge on the structure, working principles, programming methods, and data handling of PLCs—including I/O processing, tasks, function blocks, and communication interfaces—and apply this knowledge to compare relay vs. PLC logic and select an appropriate PLC controller for industrial applications.*	**09-11**
	Contents: Basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study) Centralized concept. (SLE: types of field bus systems)	
	Self-Learning Topics: Fieldbus communication systems used in industrial PLC networks.	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Apply mathematical, scientific, and engineering fundamentals to understand and explain PLC definitions, structure, working principles, firmware/software concepts, data storage, and interpretation of PLC I/O flags, variable types, and structured data used in industrial automation. (PIs - 1.1.1, 1.3.1)*	

	LO 4.2: Identify, formulate, and analyze automation problems by evaluating PLC tasks, configurations, PID behaviour, and comparing relay logic with PLC logic through case studies to arrive at justified conclusions. (PIs - 2.1.1, 2.4.1) *LO 4.3: Design PLC-based automation solutions using function blocks, operators, arrays, data structures, and structured programming methods (LD, ST, FBD, SFC) to generate and document reliable industrial control programs. (PIs - 3.1.1, 3.3.1)* *LO 4.4: Use and evaluate modern engineering tools including PLC programming software, firmware utilities, monitoring tools, PC–PLC interfacing systems, and industrial communication technologies such as Fieldbus to design, test, and validate PLC automation. (PIs - 5.1.1, 5.3.1)* *LO 4.5: Communicate PLC-related technical information by documenting PLC architecture, programming methods, I/O processing, and presenting PLC selection and program results effectively in written and oral formats. (PIs - 9.1.1, 9.3.1)* *LO 4.6: Demonstrate life-long learning skills by exploring new PLC technologies, modern Fieldbus systems, evolving communication protocols, and emerging industrial automation practices to stay updated with technological advancements. (PIs - 11.1.1, 11.3.1)*	
05.	**Applications of PLC with HMI** ***Learning Objective/s: To understand and apply PLC ladder logic operations—including logic functions, rung analysis, timers, counters, data handling, sequencers, and visualization systems—to design basic automation tasks. They will also be able to interface HMI/PC-based controllers with PLCs and develop simple HMI screens for monitoring and control.***	**04-06**
	Contents: Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI's, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation).	
	Self-Learning Topics: *Applications of HMI's, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation)*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply engineering and logical fundamentals to understand conventional ladder vs. PLC ladder diagrams, basic logic operations (AND, OR, NOT, XOR), series–parallel logic functions, and analysis of PLC rungs for industrial control applications. (PIs - 1.1.1, 1.3.1)* *LO 5.2: Identify and analyze automation problems by evaluating timer and counter instructions (ON-delay, OFF-delay, retentive types, up/down counters), combining counters with timers, and using comparison and data-handling instructions to diagnose control requirements and limitations. (PIs - 2.1.1, 2.4.1)* *Lo 5.3: Design PLC-based solutions using sequencer instructions, visualization systems, PC-based controller concepts, and structured ladder logic to create reliable HMI-based automation processes and implement control sequences for industrial systems. (PIs - 3.1.1, 3.3.1)* *Lo 5.4: Use modern engineering tools including HMI software, visualization platforms, PLC programming tools, and controller–HMI interfacing techniques to configure, test, and validate industrial automation systems (SLE: programming and implementation of HMI). (PIs - 5.1.1, 5.3.1)* *LO 5.5: Communicate automation-related technical information by documenting ladder logic analysis, timer/counter operations, sequencer design, HMI configuration techniques, and presenting control process outcomes through visual interfaces. (PIs - 9.1.1, 9.3.1)* *LO 5.6: Demonstrate life-long learning skills by exploring emerging visualization systems, modern HMI programming practices, advanced PC-based controller technologies, and continuously updating skills in industrial automation environments. (PIs - 11.1.1, 11.3.1)*	
06.	**Supervisory control & data Acquisitions**	**09-11**
	Learning Objective/s: *To impart knowledge on the architecture and communication principles of SCADA and DCS, including industrial networks and BUS/Fieldbus protocols such as GPIB, HART, OLE, FIP, PROFIBUS, and Bit-bus, interface SCADA with controllers, perform basic SCADA programming, and implement PC-based monitoring and control through case-study-based applications.*	

	Contents: Introduction to Supervisory Control & Data Acquisition (SCADA), Distributed Control System (DCS): computer networks and communication in DCS. OSI (Open Systems Interconnection) framework and its role in industrial communication architecture. Different BUS configurations used for industrial automation – GPIB, HART and OLE protocol. Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process Field Bus), Bit bus. OPC UA (Open Platform Communications Unified Architecture) protocol for secure, platform-independent industrial data exchange and interoperability. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC-based Controller / HMI, (SLE: Case study & implementation for different examples.) **Industry 4.0 Concepts:** Introduction to Industry 4.0 architecture and smart manufacturing. Cyber Physical Systems (CPS), Industrial Internet of Things (IIoT), Cloud Computing and Edge Computing in industrial automation, Digital Twin technology, Big Data Analytics and Predictive Maintenance in automated production systems. Role of SCADA and DCS in smart factory integration and real-time data-driven decision making.	
	Self-Learning Topics: *Case study on SCADA implementation for any industrial process (e.g., water tank, boiler, conveyor).*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply engineering fundamentals to understand Supervisory Control and Data Acquisition (SCADA) systems, Distributed Control Systems (DCS), industrial communication networks, and BUS configurations such as GPIB, HART, OLE, FIP, PROFIBUS, and Bit-bus used in industrial automation. (PIs - 1.1.1, 1.3.1)* *LO 6.2: Identify and analyze automation and communication problems by evaluating the behaviour, limitations, and performance of DCS networking, Fieldbus protocols, and controller–SCADA communication issues in real industrial environments. (PIs - 2.1.1, 2.4.1)* *LO 6.3: Design automation solutions by integrating SCADA with PLCs and controllers, developing basic SCADA programs, configuring DCS nodes, and creating effective monitoring & control architectures using industrial communication protocols. (PIs - 3.1.1, 3.3.1)* *LO 6.4: Use modern engineering tools including SCADA development software, DCS engineering tools, Fieldbus configuration utilities, and PC-based HMI systems to implement, test, and validate industrial automation communication networks. (PIs - 5.1.1, 5.3.1)* *LO 6.5: Communicate technical information by documenting SCADA programming steps, DCS configurations, Fieldbus network layouts, and presenting monitoring/control strategies using graphical SCADA and HMI interfaces. (PIs - 9.1.1, 9.3.1)* *LO 6.6: Demonstrate life-long learning by exploring evolving industrial communication technologies, modern Fieldbus standards, SCADA advancements, and real-world case studies (SLE) to stay updated with automation industry trends. (PIs - 11.1.1, 11.3.1)*	
	Course Conclusion This course serves as a comprehensive gateway into the world of **industrial automation and control**, empowering students with the knowledge and skills necessary to excel in advanced manufacturing environments. By covering everything from **automation principles**, **economic analysis**, and **automated system design** to **PLC programming**, **control logic**, and **industrial networking**, students are equipped to take on real-world automation challenges. Through an integrated study of **control systems**—including **PID controllers**, **timers and counters**, **HMI-SCADA integration**, and **communication**	**01**

	protocols—the course ensures that learners can implement reliable and intelligent control strategies for diverse production operations. By the end of this course, students will not only understand how to **design and analyze automated systems**, but also how to **control**, **monitor**, and **optimize** them effectively using modern tools and technologies. This positions them to contribute meaningfully to the realization of **smart factories** and the advancement of **Industry 4.0** goals.	
	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.
2.1.1	Articulate problem statements and identify objectives.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems .
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.1	Recognize that need analysis is key to good problem definition.
3.2.3	Identify suitable criteria for the evaluation of alternate design solutions.
3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development.
4.3.2	Analyze data for trends and correlations, stating possible errors and limitations.
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.3.1	Discuss limitations and validate tools, techniques and resources.
5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and non-technical information.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
9.2.2	Deliver effective oral presentations to technical and non-technical audiences.
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations.

10.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.

10.3.2 Use project management tools to schedule an engineering project, so it is completed on time and on budget.

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

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

Course Outcomes: A learner will be able to -

1. Apply mathematical tools and automation concepts to identify economic factors and perform economic evaluation of production automation systems. *(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyze automated flow lines, identify production issues, and use modern simulation tools to evaluate and validate system performance. (*LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6)*
3. Analyze automated production and material handling systems, use modern tools for simulation and evaluation, and work effectively in teams to develop integrated automation solutions. (*LO3.1, L3.2, LO3.3, LO3.4, LO3.5, LO3.6)*
4. Analyze and design PLC-based automation systems using modern tools, communicate results effectively, and stay updated with evolving industrial automation technologies. (*LO4.1, L4.2, LO4.3, LO4.4, LO4.5, LO4.6)*
5. Analyze PLC-HMI automation systems, use modern tools to validate control processes, communicate results, and stay updated with emerging automation technologies. (*LO5.1, L5.2, LO5.3, LO5.4, LO5.5, LO5.6)*
6. Analyze, design, and implement SCADA, DCS, and industrial communication networks using modern tools, communicate technical solutions effectively, and continuously update their skills in evolving automation technologies. (*LO6.1, L6.2, LO6.3, LO6.4, LO6.5, LO6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7033.1	3	3									
EEPEC7033.2	3	3			3						
EEPEC7033.3	3	3	3	3	3	3		3	3	3	
EEPEC7033.4	3	3	3		3				3		3
EEPEC7033.5	3	3	3		3				3		3
EEPEC7033.6	3	3	3		3				3		3
Average	3	3	3	3	3	3		3	3	3	3

Text Books :

1. "Automation, Production Systems and Computer Integrated Manufacturing", M.P. Grover, Pearson Education, 2015/2016.
2. "Principles and Applications of PLC", Webb John, McMillan 1992.
3. "Process Control Instrumentation Technology", Johnson Curties, Prentice hall of India, 8th edition.
4. "Programmable Logic Controllers" by W. Bolton.

Reference Books :

1. "Computer Based Industrial Control", Krishna Kant, EEE-PHI.
2. "An Introduction to Automated Process Planning Systems", Tiess Chiu Chang & Richard, A. Wysk, Prentice Hall, 1985.
3. "Anatomy of Automation", Amber G.H & P.S. Amber, Prentice Hall.
4. "Introduction to Programmable Logic Controllers", Garry Dunning, Delmar Publishers, 2nd edition.
5. "Instrumentation Engineers Hand Book - Process Control", Bela G Liptak, Chilton book company, Pennsylvania.
6. "Programmable Logic Controllers", Hugh Jack.

Other Resources :

NPTEL Course 1: https://onlinecourses.nptel.ac.in/noc21_me67/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Case Study assignment: 10 Marks
   - Think-Pair-Share/Mind Mapping/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	EEPEC7041	Smart Power System	3

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

Pre-requisite:

1. Electrical Power System
2. Renewable Energy and Energy Storage

Program Outcomes addressed:

1. PO 1: Engineering Knowledge
2. PO 2: Problem Analysis
3. PO 3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 6: The Engineer and The World
6. PO 11: Life-long learning

Course Objectives:

1. To illustrate the architecture and functional aspects of Smart Power Systems and Smart Grids.
2. To classify and summarise functions of modern sensing, communication, and data management technologies in grid operations.
3. To differentiate basic control strategies required to integration of renewable energy sources and energy storage systems.
4. To interpret the functional requirements and summarize the operational impact of intelligent automation, protection, and control schemes used in smart power networks.
5. To familiarize with cybersecurity, standards, and policy frameworks in smart grids.
6. To illustrate the practical application of advanced Smart Grid technologies by interpreting successful global or national deployment case studies.

Module	Details	Hrs.
	Course Introduction The evolution of conventional power systems into intelligent, adaptive, and sustainable networks has transformed the landscape of modern electrical energy. Smart Power Systems integrate advanced sensing, communication, and control technologies to optimize the generation, transmission, and distribution of electricity. This course explores the architecture, functional elements, and communication frameworks that enable real-time monitoring, automation, and efficient power flow management. With special emphasis on integration of	**1**

	distributed energy resources, renewable generation, and energy storage, supported by advanced metering and grid management technologies. Through a systematic study of these components, the course provides a comprehensive foundation for understanding the design, operation, and performance of contemporary power networks, highlighting the principles that ensure reliability, efficiency, and sustainability.	
01.	**Evolution of Power System** ***Learning Objective:*** *Illustration of evolution of power systems and distinguish modern smart grids, smart power systems, and microgrids along with key drivers and emerging trends.* **Contents:** Historical development of power systems; Drivers for power system transformation; Transition from conventional to modern grids; Characteristics of Smart Power Systems; Emerging trends in modern power systems; Difference between Smart Grid, Smart Power System & Microgrid ***Self-Learning Topics:*** *Global evolution journey, Key Indian initiatives: RDSS, SAUBHAGYA, Green Energy Corridors.* ***Learning Outcomes:*** *A learner will be able to* *LO1.1* *Apply fundamental engineering concepts to understand and apply principles of sustainable development to understand why modern grids prioritize efficiency, resilience, carbon reduction, and distributed energy resources. (PI 1.3.1, PI 6.3.4)* *LO1.2* *Utilize specialized electrical engineering knowledge to interpret the functioning and transformation of components within smart grids, microgrids, and modern power systems. (PI 1.4.1)* *LO1.3* *Identify and analyze the evolution of power systems terms of socio-economic, environmental, and sustainability as key drivers, challenges, and objectives behind the transition from conventional power systems to modern smart grids by articulating clear problem statements. (PI 2.1.1, PI 6.3.2)* *LO1.4* *Recognize and connect the relevant engineering principles to stay updated with emerging technologies—such as system stability, reliability, and renewable integration—to analyze modern grid requirements. (PI 2.1.3, PI 11.2.2)* *LO1.5* *Combine scientific principles and engineering concepts to develop conceptual models illustrating differences between conventional grids, smart grids, and microgrids to strengthen continuous learning skills. (PI 2.3.1, PI 11.3.1)*	**8**
02.	**Smart Devices, Digital Substation and Communication in Smart Power System** ***Learning Objective:*** *Analyse smart devices, digital substation architectures, and communication technologies to evaluate their roles in achieving efficient and interoperable smart power system operation.* **Contents:** Smart Devices: Intelligent Electronic Devices (IEDs), Architecture, functions, applications, Smart meters & Advanced Metering Infrastructure (AMI), Smart sensors & measurement transducers, Phasor Measurement Units. Digital Substations: Concept & architecture of digital substations, Process bus & station bus overview, IEC 61850 basics, Advantages: interoperability, reduced wiring, faster protection, Substation automation levels. Communication Technologies: Need for communication in modern power systems, Communication media: fiber optics, PLC, RF, cellular, satellite, SCADA; Utility communication protocols.	**8**

	Self-Learning Topics: *Time synchronization in substations (IEEE 1588 PTP), Distributed automation communication architectures*	
	Learning Outcomes: *A learner will be able to* *LO2.1 Apply fundamental and advanced engineering knowledge to model smart devices. (PI 1.1.2)* *LO2.2 Apply fundamental engineering concept to solve problems related to the functions and applications of smart devices. (PI 1.3.1)* *LO2.3 Identify, formulate, and analyze engineering problem of achieving efficient and interoperable smart power system operation. (PI 2.1.1)* *LO2.4 Combine scientific principles and engineering concepts to formulate models (mathematical or otherwise) of a smart power system or process, such as the data flow in a digital substation. (PI 2.3.1)* *LO2.5 Determine design objectives, functional requirements, and specifications for integrating Smart Devices and Digital Substations (PI 3.1.6)* *LO2.6 Refine the conceptual communication network design into a detailed digital substation architecture, while operating within resource constraints, Identifying and sourcing information to bridge the gaps on emerging communication standards and adaptability to new technology. (PI 3.4.1, PI 11.1.2)* *LO2.7 Recognize the need and be able to clearly explain why it is vitally important to keep up with new developments in smart power system technologies (PI 11.2.2)*	
03.	**Monitoring and Measurement in Smart Power System**	**8**
	Learning Objective: *Identify and evaluate smart devices, digital substation components, and communication technologies for effective operation of modern power systems.*	
	Contents: Real-time monitoring in modern grids, Phasor Measurement Units (PMUs), Wide Area Monitoring Systems (WAMS), Distribution system monitoring, Feeder monitoring, Voltage and fault detection, Data acquisition & analytics, Health monitoring of transformers, lines & equipment.	
	Self-Learning Topics: *Islanding detection techniques*	
	Learning Outcomes: *A learner will be able to* *LO3.1 Apply fundamental engineering concepts (e.g., circuit theory, signal processing) to solve problems inherent in real-time monitoring in modern grids and the physics of voltage and fault detection. (PI 1.3.1)* *LO3.2 Identify engineering systems, variables, and parameters (e.g., current, voltage, frequency, phase angle) necessary to solve problems in Distribution system monitoring and Feeder monitoring. (PI 2.1.2)* *LO3.3 Analyze existing data for trends and correlations collected from Wide Area Monitoring Systems (WAMS), and use these findings to analyze the sourced technical literature on WAMS protocols. (PI 4.3.2, PI 11.3.2)* *LO3.4 Case study 1: July 30th and 31st 2012 North India blackouts* *Objectives:* • *Evolution: Shift from the conventional grid (Module 1) due to a catastrophic real-world failure.* • *Smart Devices/ Communication: Design and implementation of WAMS, PMUs, and the fiber optic communication network (Module 2).* • *Monitoring: Use of PMU data for real-time analysis, post-facto investigation, and health monitoring (Module 3).* *Or any other relevant case study. (PI 1.3.1, PI 2.3.1, PI 4.3.2, PI 11.3.2)*	
04.	**Operation and Control in Smart Power System**	**8**
	Learning Objectives: *Analyze control strategies and operational tools in smart power systems to enhance reliability, flexibility, and grid efficiency.*	

	Contents: System Operation Overview, SCADA for control centers, Automatic Generation Control (AGC), Power system stability (qualitative), Demand Response, Distributed Automation & Self-Healing Grids, Role of Energy Storage in grid operation, Power electronics in modern power systems.	
	Learning Outcomes: *A learner will be able to* *LO4.1* *Apply fundamental engineering concepts (e.g., control system principles, time-delay analysis) to solve problems inherent in tuning the control loops for Automatic Generation Control (AGC) and maintaining Power system stability. (PI 1.3.1)* *LO4.2* *Apply electrical engineering knowledge to interpret the operational functioning and integration challenges in modern power systems. (PI 1.4.1)* *LO4.3* *Identify engineering systems, variables, and parameters (e.g., control setpoints, communication latencies) necessary to solve problems in coordinating Demand Response events. (PI 2.1.2)* *LO4.4* *Combine scientific principles and engineering concepts to formulate conceptual models (e.g., data flow diagrams, control block diagrams) for processes like the state estimation used by SCADA or the fault isolation logic of Self-Healing Grids. (PI 2.3.1)* *LO4.5* *Determine design objectives, functional requirements, and specifications for implementing control strategies, such as defining the threshold criteria and operational response for a successful Demand Response program. (PI 3.1.6)* *LO4.6* *Refine the conceptual control design for integrating Energy Storage systems (e.g., frequency regulation mode) into a detailed architecture. (PI 3.4.1)*	
05.	**Microgrid and Active Distribution Networks**	**6**
	Learning Objective/s: *Analyze the operational characteristics and benefits of microgrids and active distribution networks.*	
	Contents: **Microgrids:** Concept and components of microgrids, Characteristics of microgrids, Operating modes: grid-connected vs islanded, Control hierarchy (only overview), benefits. **Active Distribution Networks:** Concept of active vs passive distribution networks, Integration of DERs into distribution systems, Bidirectional power flow in distribution systems, Role of smart inverters, Volt-VAR and Volt-Watt control (conceptual), Protection issues in active networks, Role of storage and EVs in active grids.	
	Learning Outcomes: *A learner will be able to* *LO5.1* *Apply fundamental engineering concepts (e.g., power quality, stability) to solve problems inherent in the integration of DERs into distribution systems. (PI 1.1.1)* *LO5.2* *Apply electrical engineering knowledge to interpret the functioning and control hierarchy of a Microgrid (PI 1.4.1)* *LO5.3* *Identify engineering systems, variables, and parameters necessary to solve the problem of mitigating Protection issues in active networks caused by the integration of distributed generation. (PI 2.1.2)* *LO5.4* *Combine scientific principles and engineering concepts to formulate models illustrating the operational differences between active vs. passive distribution networks. (PI 2.3.1)* *LO5.5* *Determine design objectives, functional requirements, and specifications for a Microgrid's core components. (PI 3.1.6)* *LO5.6* *Refine the conceptual control design with existing/ with new developments for integrating the Role of storage and EVs in active grids into a detailed architecture. (PI 3.4.1, PI 11.2.2)*	

	LO5.7 *Source and comprehend technical literature and other credible sources of information regarding the latest control schemes and operating modes for both Microgrids and Active Distribution Networks. (PI 11.3.1)*	
06.	**Cybersecurity in Smart Power Systems** ***Learning Objective/s:*** *Analyze cybersecurity threats and evaluate standards and protective measures to secure modern power system operations.*	**5**
	Contents: Introduction to cyber risks in power systems, Vulnerabilities in modern power system components, Types of cyber-attacks, Cybersecurity standards, Basic mitigation strategies, Building a cyber-resilient smart power system.	
	Learning Outcomes:	
	A learner will be able to *LO6.1* *Apply fundamental engineering concepts (e.g., network protocols, encryption, control system architecture) to solve engineering problems related to securing data flow between the physical and digital domains of the power system. (PI 1.3.1)* *LO6.2* *Identify, formulate, and analyze engineering problem of securing the entire operational technology (OT) environment against emerging cyber risks in power systems. (PI 2.1.2)* *LO6.3* *Combine scientific principles and engineering concepts to formulate conceptual models (e.g., threat models, attack trees) illustrating potential Types of cyber-attacks against control center and substation networks. (PI 2.3.1)* *LO6.4* *Determine design objectives, functional requirements, and specifications for implementing Basic mitigation strategies and protective controls (e.g., firewall rules, intrusion detection systems) to protect critical smart grid assets. (PI 3.1.6)* *LO6.5* *Refine the conceptual design of a security architecture with existing/ with new developments Building a cyber-resilient smart power system, operating within constraints such as latency and regulatory compliance. (PI 3.4.1, PI 11.2.2)* *LO6.6* *Case study 2: October 2020 Mumbai Grid Disturbance/ any other case study.* *Objectives:* • *Operation and Control in Smart Power System. (Module 4)* • *Microgrid and Active Distribution Networks. (Module 5)* • *Cybersecurity in Smart Power Systems. (Module 6)* *Or any other relevant case study. (PI 1.3.1, PI 2.3.1, PI 4.3.2, PI 11.3.2)*	
	Course Conclusion By the end of this course, Learners will have acquired a clear understanding of the structure, operation, and key technologies that define modern smart power systems. Highlighting the role of communication frameworks, automation, renewable integration, and energy storage in enhancing reliability, efficiency, and sustainability of power networks. Equipped with this conceptual foundation, readers will be prepared to engage with emerging trends, standards, and innovations in smart grid design and operation, forming a strong base for advanced study or professional practice in the evolving field of intelligent energy systems.	**1**
	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.
2.1.1	Articulate problem statements and identify objectives

2.1.2 Identify engineering systems, variables, and parameters to solve the problems.
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.2 Identify, assemble and evaluate information and resources.
2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
2.4.3 Identify sources of error in the solution process, and limitations of the solution.
2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.1.5 Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural, whole-life cost, net zero carbon, culture, environment and societal issues
3.1.6 Determine design objectives, functional requirements and arrive at specifications.
3.3.1 Apply formal decision-making tools to select optimal engineering design solutions for further development
3.4.1 Refine a conceptual design into a detailed design within the existing constraints (of the resources)
4.1.1 Define a problem, its scope and importance for purposes of investigation.
4.1.4 Establish a relationship between measured data and underlying physical principles
4.3.2 Analyse data for trends and correlations, stating possible errors and limitations.
4.3.4 Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions.
6.3.1 Identify risks/impacts in the life-cycle of an engineering product or activity
6.3.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
6.3.4 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
11.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.1 Source and comprehend technical literature and other credible sources of information
11.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes:

A learner will be able to -

1. Apply knowledge of the power system's historical development to distinguish features of modern smart power systems, including architecture, sustainability drivers, and enabling technologies. *(LO1.1, LO1.2, LO1.3, LO1.4, LO1.5)*
2. Interpret the roles of smart devices, digital substations, and communication technologies in smart power systems. *(LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6, LO2.7)*
3. Identify real-time measurement data, monitoring systems and equipment health indicators to support operational decision-making in smart power systems. *(LO3.1, LO3.2, LO3.3, LO 3.4)*
4. Identify the functions of system operation tools and energy storage in maintaining grid stability and flexibility. *(LO4.1, LO4.2, LO4.3, LO4.4, LO4.5, LO4.6)*
5. Compare microgrid components, operating modes, and active distribution network features. *(LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO5.6, LO5.7)*
6. Integrate cybersecurity measures by identify cyber risks, vulnerabilities, attack types, security standards in smart power systems. *(LO 6.1, LO6.2, LO6.3, LO6.4, LO6.5, LO6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7041.1	3	3				3					3

EEPEC7041.2	3	3	3								3
EEPEC7041.3	3	3		3							3
EEPEC7041.4	3	3	3								
EEPEC7041.5	3	3	3								3
EEPEC7041.6	3	3	3								3
Average	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**3**		**3**

Text Books:

1. J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Hoboken, NJ, USA: Wiley-IEEE Press, 2012.
2. F. P. Sioshansi, *Smart Grid: Integrating Renewable, Distributed and Efficient Energy*, San Diego, CA, USA: Academic Press, 2012.
3. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, and N. Jenkins, *Smart Grid: Technology and Applications*, Chichester, U.K.: Wiley, 2012.

Reference Books:

1. A. Keyhani, *Design of Smart Power Grid Renewable Energy Systems*, 2nd ed., Hoboken, NJ, USA: Wiley, 2016.
2. S. A. Khaparde and S. V. Kulkarni, *Smart Grid: Technology and Applications*, New Delhi, India: McGraw-Hill Education, 2020.
3. J.-C. Sabonnadière and N. Hadjsaïd, *Smart Grids*, London, U.K.: Wiley-ISTE, 2011.
4. S. W. Fardo and D. R. Patrick, *Electrical Power Systems Technology*, Boca Raton, FL, USA: CRC Press, 2015.
5. H. Farhangi, *The Path of the Smart Grid*, Hoboken, NJ, USA: Wiley, 2019.

Other Resources:

1. NPTEL – *Smart Grid: Integration and Control*, IIT Roorkee.
2. NPTEL – *Power System Automation*, IIT Kanpur.

IN-SEMESTER ASSESSMENT (75 MARKS)

1. **Continuous Assessment - Theory-(20 Marks)**

   02 Class tests: (5 marks each)

   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 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	EEPEC7042	Power Quality and FACTS	3

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. EEPCC408 - Power System Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The engineer and society
4. PO8: Individual and team work
5. PO11: Life-long learning

Course Objectives:

1. To impart knowledge on fundamentals of power quality, the generation and effects of harmonics, and their measurement in electrical systems.
2. To introduce methods for power factor improvement, harmonic mitigation, and reactive power control using shunt and series compensators.
3. To teach principles, applications, and significance of FACTS devices and advanced hybrid controllers for voltage stability and power flow control in modern power systems.

Module	Details	Hrs
	Course Introduction Power quality is essential for reliable and efficient operation of electrical systems. Flexible AC Transmission Systems (FACTS) enhance power quality by improving voltage stability, controlling power flow, and mitigating disturbances. Studying power quality and FACTS helps in identifying issues and applying effective solutions.	**01**
01.	**Introduction to Power Quality**	**04**
	Learning Objective/s: *To impart knowledge on various power quality disturbances and their impact on voltage, frequency, and overall system performance.*	
	Content Transient and steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, harmonics, noise, notching, dc-offsets, fluctuations, flicker. Impact of voltage and frequency variation on system reliability	

	Learning Outcomes: *A learner will be able to* *LO1.1 Apply electrical engineering concepts to understand transient and steady-state variations in voltage and frequency (PI 1.4.1)* *LO 1.2 Apply fundamental engineering concepts to understand unbalance, sags, swells, interruptions, harmonics, noise, notching, DC offsets, fluctuations, and flicker. (PI 1.3.1)* *LO1.3 Identify and categorize various power quality disturbances in electrical systems. (PI 2.2.1)* *LO1.4 Analyze the effects of voltage and frequency variations on equipment performance and system reliability. (PI 2.1.3)*	
02.	**Harmonics and its Effects**	**07**
	Learning Objective/s: *To teach causes, characteristics, and effects of harmonics in power systems and their impact on electrical equipment and system performance.*	
	Contents: Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads, Inter-harmonics, Effects of harmonics on rotating Machines, Transformers and Cables, Overloading of Neutral conductor.	
	Self-Learning Topic *FFT analysis of current and voltage waveforms.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1 Apply the principles of harmonic analysis to calculate voltage and current distortions in electrical systems. (PI 1.3.1)* *LO 2.2 Apply harmonic analysis methods to compute harmonic indices and evaluate their impact on electrical systems. (PI 1.4.1)* *LO 2.3 Analyze various sources of harmonics in electrical systems and classifying them (PI 2.4.1)* *LO 2.4 Assess the impact of harmonics on electrical equipment and system reliability. (PI 2.1.3)*	
03.	**Power Quality Improvement**	**09**
	Learning Objective/s: *To teach methods for improving power factor and mitigating power quality issues*	
	Contents: Power factor compensation using capacitor (vector diagram and numerical included), Power factor when both voltage and current are sinusoidal, power factor when voltage is sinusoidal and current is non-sinusoidal (numerical included), Mitigation of harmonics- Passive filters- Advantages and disadvantages of passive filters- Active filters, Instantaneous PQ theory.	

	Learning Outcomes: *A learner will be able to* *LO3.1 Apply capacitor-based compensation for different voltage/current conditions. (PI 1.3.1)* *LO3.2 Analyze and determine the effectiveness of passive and active filters in reducing harmonics and improving power quality in electrical systems. (PI 2.4.2)* *LO3.3 Analyze real systems to detect low power factor and harmonic disturbances. (PI 2.4.1)* *LO3.4 Apply instantaneous PQ theory for real and reactive power control in three-phase systems to improve power quality, demonstrating teamwork and lifelong learning. (PI 1.4.1, PI 8.1.1, PI 11.2.2)*	
04.	**General Concept of FACTS**	**08**
	Learning Objective/s: *To impart knowledge on concept of Flexible AC Transmission Systems (FACTS), their role in reactive power control and their importance in enhancing transmission network performance.*	
	Contents: The concept of flexible AC transmission– Transmission Interconnections, reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network.	
	Self-Learning Topics: *Stability issues in transmission lines.*	
	Learning Outcomes: *A learner will be able to* *LO4.1 Apply the concepts of reactive power to evaluate its impact on voltage regulation in transmission lines. (PI 1.3.1)* *LO4.2 Apply the concepts of FACTS devices to enhance transmission efficiency and system stability. (PI 1.4.1)* *LO4.3 Analyze limitations of uncompensated lines and justify the need for reactive power compensation. (PI 2.2.1)* *LO4.4 Analyze the impact of FACTS implementation on voltage profile, stability, and power flow control. (PI 2.2.4)*	
05.	**Static Shunt and Series Compensators**	**08**
	Learning Objective/s: *To teach various compensation techniques and devices for enhancing the performance and stability of power systems.*	
	Contents Objectives of series and shunt compensation, Variable impedance type static var generator (TCR, TSR, TSC, FC-TCR) description of static var compensators (SVC), thyristor controlled series compensators (TCSC),static synchronous series compensator (SSSC),STATCOM.	
	Learning Outcomes: *A learner will be able to* *LO5.1 Compare shunt vs series compensation and identify suitable compensators for various system requirements. (PI 2.1.3)* *LO5.2. Apply fundamental engineering concepts to understand the working of TCR, TSR, TSC, FC-TCR in controlling reactive power. (PI 1.3.1)*	

	LO5.3 Evaluate the effectiveness of SVC, TCSC and SSSC in improving power system performance through collaborative teamwork in poster creation. (PI 2.4.1, PI 8.3.1) *LO5.4 Apply principles of series and shunt compensation to interpret the operation of STATCOM for dynamic reactive power compensation and voltage regulation in transmission networks. (PI 1.4.1)*	
06.	**Hybrid FACTS Controllers:**	**07**
	Learning Objective/s: *To impart knowledge on principles, operation, and applications of UPFC, IPFC, and static voltage and phase angle regulators in power system control.*	
	Contents: Unified Flow Controller (UPFC)–Principle of operation, modes of operation, applications Power, Interline Power Flow Controller (IPFC). Introduction to Static voltage and phase angle regulators.	
	Learning Outcomes: *A learner will be able to* *LO6.1 Apply the working principles of UPFC, IPFC, and voltage/phase angle regulators to understand their operation in power flow control. (PI 1.4.1)* *LO6.2 Apply UPFC/IPFC modes to match suitable applications in power system networks. (PI 1.3.1)* *LO6.3 Recognize scenarios where hybrid FACTS controllers are required to enhance the reliability, efficiency, and societal benefits of electrical power systems. (PI 2.4.1, PI 6.1.1)* *LO6.4 Evaluate the effectiveness of voltage/phase regulators in minimizing power losses and supporting modern electrical infrastructure. (PI 2.4.2, PI 6.2.1)*	
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4.1	Apply Electrical engineering concepts to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.1	Reframe complex problems into interconnected sub problems Identify
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.4.1	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
11.2.2	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:

1. Identify and describe various power quality issues in electrical systems. (*LO1.1, LO1.2, LO1.3, LO1.4)*
2. Apply knowledge to explain the causes and effects of harmonics on electrical equipment. (*LO2.1, LO 2.2, LO 2.3, LO 2.4)*

3. Apply suitable methods to improve power factor and mitigate harmonics. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
4. Analyze the concept and importance of FACTS devices in power systems. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
5. Analyze the operation and applications of shunt and series compensators. (*LO 5.1, LO5.2, LO 5.3, LO 5.4)*
6. Evaluate the performance and significance of hybrid FACTS controller. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7042.1	3	3									
EEPEC7042.2	3	3									
EEPEC7042.3	3	3						2			2
EEPEC7042.4	3	3									
EEPEC7042.5	3	3						2			
EEPEC7042.6	3	3									
Average	3	3						2			2

Text Books :

1. Roger C. Dugan, “Electrical Power Systems Quality”, McGraw-Hill Publication
2. G.T. Heydt, “Electric Power Quality”, Starsina Circle Publications
3. T.J.E. Miller, “Reactive Power Control in Electrical System”, John Wiley and Sons, New York, 1982.
4. N.G. Hingorani, “Understanding FACTS: Concepts and Technology of FACTS Systems”, IEEE Press, 2000

Reference Books :

1. J. Arrillaga ,N.R .Watson, “Power System Quality Assessment”, John Willey & Sons
2. K.R. Padiyar ”FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007

Other Resources:

1. NPTEL course on Power Quality Improvement Technique, IIT Roorkee Prof. Avik Bhattacharya https://nptel.ac.in/courses/108107157
2. NPTEL course on Facts Devices By Prof. Avik Bhattacharya IIT Roorkee https://onlinecourses.nptel.ac.in/noc23_ee58/preview

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
Poster creation: 05 Marks
Case study and report submission: 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
PE	EEPEC7043	Artificial Intelligence in Renewable Energy System	04

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

Pre-requisite :

1. ESL103: Programming Laboratory-II(C)
2. ECMDM6048: Smart Electronic Systems

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering tool usage
4. PO6: The Engineer and the World
5. PO8: Individual and Collaborative Team Work
6. PO9: Communication

Course Objectives :

1. To comprehend the concepts and importance of Artificial Intelligence (AI) in renewable energy systems.
2. To know about the working principles of Artificial Neural Networks (ANN), Fuzzy Logic, and hybrid intelligent systems.
3. To comprehend strength and weakness of problem solving and optimization algorithms.
4. To explore machine learning and deep learning techniques for forecasting, prediction, and fault diagnosis in renewable systems.
5. To develop skills in designing and simulating AI-based control, forecasting, and energy management models using MATLAB and AI frameworks.

Module	Details	Hrs.
	Course Introduction This course introduces intelligent control and prediction techniques for renewable energy systems using Artificial Intelligence (AI) approaches such as Fuzzy Logic, and Artificial Neural Networks (ANN). It focuses on applying these soft computing methods to optimize power generation, manage energy flow, and enhance system reliability in hybrid renewable setups. Students will learn how fuzzy logic and ANN-based algorithms can be designed, trained, and implemented for applications like MPPT control, fault diagnosis, and renewable energy forecasting. By the end of the course, learners will be able to develop intelligent controllers for efficient operation of PV, wind, and hybrid energy systems.	**01**
01.	**Overview of AI Techniques** ***Learning Objective:*** *To comprehend basic AI&ML techniques and its applications in renewable energy systems.*	**7**
	Contents:	

	Introduction to AI: Concept, Scope and Importance. **Challenges in Renewable Energy Systems:** Intermittency, Variability and Storage issues. **AI Techniques:** Machine learning, Fuzzy logic, Neural networks. **AI Applications in Renewable energy systems:** Forecasting, fault detection and control, Predictive maintenance.	
	Self-Learning Topics: *Review IEEE paper based on any one AI application in Renewable energy systems.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental AI concepts to identify the challenges in renewable energy systems. (PI-1.3.1)* *LO 1.2: Apply electrical engineering concepts to assess the challenges in renewable energy systems. (PI-1.4.1)* *LO 1.3: To demonstrate the technical and environmental impacts of AI applications in PV forecasting and battery health diagnostics by examining performance metrics, efficiency gains, and sustainability outcomes. (PI-6.3.2)* *LO 1.4: To explore AI-driven preventive and sustainable engineering methods such as PV inverter fault prediction and optimized battery management to promote efficient energy management. (PI-6.3.4)*	
02.	**ANN for Renewable Energy Systems** ***Learning Objective:*** *To identify different AI learning algorithms to solve engineering problems.*	**7**
	Contents: **ANN architectures:** Feedforward, feedback, multilayer perceptron (MLP). **Learning Algorithms:** Supervised and unsupervised learning, backpropagation. **Applications of ANN in renewable energy:** solar irradiation and temperature forecasting, MPPT control in PV systems.	
	Self-Learning Topics: *MPPT control of PV using suitable AI learning algorithms.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply fundamental concepts of different learning algorithms and techniques to solve engineering problems. (PI-1.3.1)* *LO 2.2: Apply electrical engineering concepts to interpret the data and analyze engineering problems. (PI-1.4.1)* *LO 2.3: Identify and apply appropriate learning algorithm/technique to solve problems. (PI-2.1.2)* *LO 2.4: Compare performance of different learning algorithms/techniques and select the most suitable one for a particular AI application. (PI-2.2.4)*	
03.	**Fuzzy Logic systems** ***Learning Objective:*** *To identify the principles of fuzzy logic systems to solve engineering problems.*	**6**
	Contents: **Fundamentals of fuzzy logic:** fuzzy sets, membership functions, and fuzzy inference system. **Applications:** Fuzzy rule based decision making for energy flow control in Microgrids, Fuzzy logic-based MPPT for PV systems.	
	Self-Learning Topics: *MATLAB simulation of fuzzy controller for any one renewable application.*	

	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply fundamental concepts of fuzzy logic systems in intelligent control of renewable energy systems. (PI-1.3.1)* *LO 3.2: Apply electrical engineering concepts to analyze renewable energy system data for fuzzy logic control. (PI-1.4.1)* *LO 3.3: To demonstrate the technical and environmental dimensions adaptive energy management in renewable energy systems and implement fuzzy-logic based preventive control strategies to support sustainable system operation. (PI-6.3.2, PI-6.3.4)*	
04.	**Optimization Algorithms** ***Learning Objectives:*** *Identify suitable optimization algorithms to solve engineering problems.*	**6**
	Contents: **Overview:** Need for optimization algorithms, classical and metaheuristic methods. **Genetic Algorithm (GA):** selection, crossover, mutation, and convergence. **Particle Swarm Optimization (PSO):** velocity and position update, parameter tuning. Applications of GA and PSO in converter parameter tuning.	
	Self-Learning Topics: MATLAB-based simulation of any one-optimization algorithm.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply fundamental principles of optimization algorithms to solve engineering problems. (PI-1.3.1)* *LO 4.2: Apply electrical engineering concepts to analyze suitable data for intelligent control of renewable energy systems. (PI-1.4.1)* *LO 4.3: Identify and apply appropriate optimization algorithm/technique to solve engineering problems. (PI-2.1.2)* *LO 4.4: Compare performance of different optimization algorithms/techniques and select the most suitable one for a particular AI application. (PI-2.2.4)*	
05.	**Machine learning and Deep learning techniques** ***Learning Objective/s:*** *Identify and apply ML/DL architectures for predictive maintenance and fault detection in renewable energy systems.*	**7**
	Contents: **Overview:** Machine learning and deep learning frameworks**,** Regression, classification, and clustering for renewable energy data. Use of SVM for energy prediction. **Deep Learning Architectures**: CNN (Convolutional Neural Network), Data collection and preprocessing for ML/DL models, AI-based predictive maintenance and fault detection in renewable systems.	
	Self-Learning Topics: Exploring tools like MATLAB Predictive Maintenance Toolbox for result visualization.	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply knowledge of engineering fundamentals to develop ML/DL models for renewable energy prediction. (PI-1.3.1)* *LO 5.2: Apply electrical engineering fundamentals to design ML/DL models that accurately forecast renewable energy generation. (PI-1.4.1)* *LO 5.3: Identify suitable ML/DL algorithms to solve renewable energy forecasting and fault detection problems. (PI-2.1.2)*	

	LO 5.4: Assess model performance accurately and understand the implications of various error measures. (PI-2.4.3) LO 5.5: Demonstrate awareness of the role of AI-based predictive maintenance in sustainable and reliable renewable energy operation. (PI-6.3.2, PI-6.3.4)	
06.	**Case studies** ***Learning Objective/s:*** *To enable students to apply machine learning and deep learning techniques for renewable energy forecasting, predictive maintenance, and intelligent energy management.* **Contents:** AI based energy management in micro grids, Fault detection and diagnosis in PV systems, Smart forecasting of Renewable generation, Battery management systems, Recent research trends and future directions in AI for renewable systems. **Note: Case study simulation based assignments will be based on above areas of application of AIML in Renewable energy Systems.** ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply fundamental concepts of AI/ML concepts to solve engineering problems. (PI-1.3.1)* *LO 6.2: Apply electrical engineering concepts to interpret results and determine appropriate solution approaches. (PI- 1.4.1)* *LO 6.3: Examine the solution process to identify the errors and interpret the limitations of the AI-based solution. (PI-2.4.3)* *LO 6.4. Demonstrate the various mathematical assumptions required for modelling of AI/ML enabled sustainable energy systems.(PI-2.3.2)* *LO 6.5: Identify different AI software tools to adapt in Renewable energy domain applications with the help of case study/research literature and submit report for the same as a team. (PI-5.1.1, 5.1.2, 8.2.1, 8.3.1, 9.1.1, 9.1.2)*	**7**
	Course Conclusion This course provides a comprehensive understanding of Machine Learning and Deep Learning models that can be effectively applied to renewable energy systems. Students gain the ability to develop intelligent models for energy forecasting, management, and fault detection in micro grids and photovoltaic systems. By integrating theoretical concepts with practical applications, learners become equipped to analyze real-time renewable energy data, implement AI-based predictive solutions, and explore emerging research trends in sustainable energy technologies.	**01**
	Total	**42**

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.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.

6.3.4 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1 Read, understand and interpret technical and non-technical information.
9.1.2 Produce clear, well-constructed, and well-supported written engineering documents.

Course Outcomes: A learner will be able to –

1. Demonstrate the significance and practical applications of Artificial Intelligence techniques for enhancing the efficiency and sustainability of renewable energy systems. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4).*
2. Apply intelligent learning algorithms to optimize the performance of renewable energy systems and promote sustainable operation. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4).*
3. Apply fuzzy logic controllers to manage energy flow and implement MPPT for renewable energy systems. *(LO 3.1, LO 3.2, LO 3.3)*
4. Employ optimization algorithms for tuning system parameters and improving energy management in renewable energy systems. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4).*
5. Apply ML/DL techniques for fault detection, and predictive maintenance in renewable energy systems. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5).*
6. Apply AI and deep learning techniques to solve engineering problems in the renewable energy domain, work collaboratively in a team, and explore recent research trends to promote sustainable energy solutions. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EEPEC7043.1	3					3					
EEPEC7043.2	3	3									
EEPEC7043.3	3					3					
EEPEC7043.4	3	3									
EEPEC7043.5	3	3				3					
EEPEC7043.6	3	3			3			3	3		
Average	3	3			3	3		3	3		

Text Books :

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.
5. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", 1st Edition, Morgan-Kaufmann, 1998.
6. R. O. Duda, E. Hart, and D.G. Stork, "Pattern Classification", Second Edition, John Wiley & Sons, Singapore, 2012.

7. Francois Chollet, “Deep Learning with Python”, Manning Publications, Shelter Island, New York, 2018.

Reference Books :

1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, “Artificial Intelligence”, McGraw Hill, 3rd ed.,2017.
2. Patterson, “Introduction to Artificial Intelligence & Expert Systems”, Pearson, 1st ed. 2015.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH
5. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, MIT Press, 2014.
6. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
7. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
8. Navin Kumar Manaswi, “Deep Learning with Applications using Python”, A press, New York, 2018.

Other Resources :

1. NPTEL Course: Artificial Intelligence and Machin Learning, Prof. Krishanu Biswas, IIT Kanpur https://onlinecourses.nptel.ac.in/noc24_ce107/preview.

IN-SEMESTER ASSESSMENT (50 MARKS)

Continuous Assessment - Theory-(20 Marks)

Case Study Assignments: 10 Marks
Flipped Classroom: 5 Marks
Regularity and Active Participation: 5 Marks

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
OEC	OEC7011	Product Life Cycle Management	03

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

Program Outcomes addressed:

1. PO3 : Design / Development of Solutions
2. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction to Product Lifecycle Management (PLM)**	**9-11**
	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications, PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	
02.	**Product Design**	**9-11**
	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	

03.	**Product Data Management (PDM)**	**5-7**
	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
04.	**Virtual Product Development Tools**	**5-7**
	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05.	**Integration of Environmental Aspects in Product Design**	**5-7**
	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06.	**Life Cycle Assessment and Life Cycle Cost Analysis**	**4-6**
	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7011.1	-	-	-	-	-	3	-	-	-	3	-
OEC7011.2	-	-	3	-	-	-	-	-	-	3	-
OEC7011.3	-	-	3	-	-	-	-	-	-	-	-
OEC7011.4	-	-	3	-	-	-	-	-	-	3	-
Average	-	-	**3**	-	-	**3**	-	-	-	**3**	-

References :

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105

2. Fabio Giudice, Guido La Rosa, Antonino Risitano, “Product Design for the environmentA life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC7012	Reliability Engineering	03

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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO 4: Conduct investigations of complex problems
5. PO 5: Engineering Tool Usage

Course Objectives:

1. To familiarize the students with various aspects of probability theory.
2. To acquaint the students with reliability and its concepts.
3. To introduce the students to methods of estimating the system reliability of simple and complex systems.
4. To understand the various aspects of Maintainability, Availability and FMEA procedure.

Module	Details	Hrs.
	Course Introduction Reliability Engineering is a vital discipline within engineering that focuses on ensuring systems and components perform their intended functions consistently over their expected lifetime. The course introduces students to the principles, tools, and methodologies used to analyze, predict, and improve the reliability of engineering systems. Students will explore key concepts such as failure mechanisms, probability models, reliability metrics, system configurations, maintenance strategies, and life data analysis. Through theoretical understanding and practical applications, the course aims to develop the ability to design reliable products, evaluate system performance, and implement reliability improvement programs in real-world engineering environments. By the end of the course, learners will gain a strong foundation in reliability concepts and become capable of applying these principles across various domains including mechanical, electrical, electronic, and manufacturing systems.	**01**
	Contents:	

	Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Rules for combining probabilities, independent, mutually exclusive, complimentary, conditional events, simultaneous occurrence of events.	
02.	**Reliability Concepts** **Contents:** Reliability definitions, Reliability functions, Importance of Reliability, Quality Assurance and Reliability. Failure- causes of failures, modes of failures, Bath Tub Curve Failure Data Analysis: Failure density, Mean Time to Failure (MTTF), Mean time between failure (MTBF).	**7-9**
03.	**Reliability Hazard Models** **Contents:** Hazard rate, Constant Hazard, Hazard Models –Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution MTTF in terms of failure Density, Mean time in failure in integral form functions and reliability analysis.	**6-8**
04.	**System Reliability** **Contents:** System Configurations: Series, parallel, mixed configuration, k- out of n structure, Complex systems. Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	**5-7**
05.	**Maintainability and Availability** **Contents:** Maintainability, System Down time, Reliability and Maintainability tradeoff. Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability– qualitative aspects, Availability measures	**7-9**
06.	**Failure Mode, Effects & Criticality Analysis and Fault Tree Analysis** **Contents:** Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, Fau1t tree analysis and Event Tree Analysis. Fault Tree Analysis, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event Tree Analysis.	**7-9**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply the concept of Probability theory to engineering problems.
2. Understand fundamental concept of reliability to calculate different reliability parameters.
3. Differentiate between reliability hazard models.
4. Illustrate the understanding of System Reliability.

5. Illustrate the various aspects of Maintainability and Availability
6. Familiarize with the FMECA and able to construct fault tree diagrams.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7012.1	3	3	--	--	--	--	--	--	--	--	--
OEC7012.2	3	3	--	--	3	--	--	--	--	--	--
OEC7012.3	3	3	--	3	--	--	--	--	--	--	--
OEC7012.4	3	3	3	3	--	--	--	--	--	--	--
OEC7012.5	3	3	3	--	--	--	--	--	--	--	--
OEC7012.6	3	3	3	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**3**	**3**	--	--	--	--	--	--

Text Books :

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. E. Balagurusamy, “Reliability Engineering”, Mcgraw Hill Education (India), 2003.

Reference Books :

1. P.D.T. Conor, “Practical Reliability Engineering”, John Wiley & Sons, 1985.
2. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.3
3. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Other Resources :

1. Introduction to Reliability Engineering
   Link - https://nptel.ac.in/courses/127105234

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 Marks)

Suggested breakup of distribution

Class Test	:	05 Marks
MCQ test as per GATE exam pattern / level	:	05 Marks
Open book Test	:	05 Marks
Regularity and active participation	:	05 Marks

1. 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
OEC	OEC7013	Management Information System	03

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

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction To Information Systems (IS)**	**3-5**
	Contents: Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
02.	**Data and Knowledge Management**	**7-9**
	Contents: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	
03.	**Ethical issues and Privacy**	**7-9**
	Contents: Information Security. Threat to IS, and Security Controls	
04.	**Social Computing (SC)**	**7-9**
	Contents: Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
05.	**Computer Networks**	**6-8**
	Contents: Wired and Wireless technology, Pervasive computing, Cloud computing model	
06.	**Information System within Organization**	**7-9**

	Contents: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Explain how information systems Transform Business.
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7013.1	3	-	-	-	-	3	-	-	-	-	-
OEC7013.2	3	-	-	-	-	3	-	-	-	-	-
OEC7013.3	3	-	-	-	-	-	-	-	-	-	-
OEC7013.4	3	-	-	-	-	-	-	-	-	3	-
OEC7013.5	3	-	-	-	-	-	-	-	-	3	-
Average	**3**	-	-	-	-	3	-	-	-	3	-

References :

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC7014	Design of Experiments	03

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

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO4 : Conduct Investigations of Complex Problems
4. PO5 : Engineering Tool Usage

Course Objectives :

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction**	**5-7**
	Contents: Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology	
02.	**Fitting Regression Models**	**8-10**
	Contents: Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit	
03.	**Two-Level Factorial Designs** **Contents:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs	**7-9**
04.	**Two-Level Fractional Factorial Designs** **Contents:** The One-Half Fraction of the 2k Design, The One-Quarter Fraction of the 2 k Design, The General 2k-p Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs	**7-9**
05.	**Response Surface Methods and Designs** **Contents:**	**7-9**

	Introduction to Response Surface Methodology , The Method of Steepest Ascent, Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces	
06.	**Taguchi Approach** **Contents:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples	**3-5**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7014.1	3	3	-	3	-	-	-	-	-	-	-
OEC7014.2	3	3	-	-	3	-	-	-	-	-	-
OEC7014.3	3	-	-	3	3	-	-	-	-	-	-
Average	**3**	**3**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**

References :

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3 rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7015	Operation Research	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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO6: The Engineer & The world
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the concept of formulation of a real-world problem as a mathematical programming model.
2. To impart the knowledge of the mathematical tools that are needed to solve optimization problems.
3. To make learner able to use mathematical software to solve the proposed models.
4. To impart the mathematical understanding to analyse and solve integer programming from a wide range of applications.

Module	Detailed Contents	Hrs
	Course Introduction Operations Research (OR) course is an interdisciplinary field that applies advanced analytical, mathematical, and statistical methods to make better decisions in complex systems, optimizing processes and resource allocation. Students learn to identify problems, formulate mathematical models like linear programming, and use algorithms to find optimal solutions for real-world issues in areas such as engineering, management, finance, and logistics.	**01**
01.	**Introduction to Operations Research** **Content:** Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method, Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation	**15-17**

	problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02.	**Queuing models**	**04-06**
	Contents: Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population.	
03.	**Simulation**	**06-08**
	Contents: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04.	**Dynamic programming**	**06-08**
	Contents: Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	
05.	**Game Theory**	**04-06**
	Contents: Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
06.	**Inventory Models**	**04-06**
	Contents: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Apply simplex method, analyse the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change
3. Solve specialized linear programming problems like the transportation and assignment problems.

4. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
5. Analyse the applications of integer programming and a queuing model and compute important performance measures

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7015.1	3	3	3	-	-	-	-	-	-	-	-
OEC7015.2	3	3	-	-	-	-	-	-	-	-	-
OEC7015.3	3	3	3	-	-	3	-	-	-	3	3
OEC7015.4	3	3	3	-	-	3	-	-	-	3	3
OEC7015.5	3	3	3	-	-	3	-	-	-	-	3
Average	**3**	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**

Text Books :

1. Operations Research - An Introduction, Taha, H.A., Seventh Edition 2002, Prentice Hall.
2. Operations Research, S. D. Sharma, First Edition, 2012, KedarNath Ram Nath-Meerut Company
3. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Twentieth Edition, 2022 Sultan Chand & Sons

Reference Books :

1. Operation Research-Methods and problems, Saiesini M.,Yaspan A., First Edition, 1959, Prentice Hall
2. Operations Research: Principles and Practice, Ravindran, A, Phillips, D. T and Solberg, J. J., Second edition, 2009, John Willey and Sons.
3. Introduction to Operations Research, Hiller, F. S. and Liebermann, G. J., Fourth edition, 2002, Tata McGraw Hill

Other Resources :

1. NPTEL Course: Introduction to Operation Research, Prof. G.Srinivasa, IIT Madras
   Web Link- https:// nptel.ac.in/courses/110106062
2. NPTEL Course: Operations Research, Prof. Kusum Deep, IIT Roorkee
   Web Link- https://onlinecourses.nptel.ac.in/noc22_ma48/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7016	Cyber Security and Laws	03

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

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design and Development of Solution
4. PO 4: Conduct investigation of Complex Problem
5. PO 5: Engineering Tool Usage
6. PO 11: Life-long learning

Course Objectives:

1. To define and categorize various forms of cybercrime, including malware attacks, social engineering, financial fraud, and network intrusions, while understanding their technical and societal impacts.
2. To analyse the legal frameworks governing cyber activities, with a focus on distinguishing between different types of cyber laws at national and international levels.
3. To examine the key provisions and structure of the Indian IT Act, 2008, and to evaluate the implications of its latest amendments on digital governance, privacy, and cybercrime adjudication.
4. To identify and compare global information security standards and compliance frameworks, such as ISO 27001, PCI-DSS, GDPR, HIPAA, and NIST, and their relevance to organizational security postures.
5. To apply legal and compliance knowledge in practical scenarios, enabling students to assess organizational compliance requirements and recommend appropriate security controls within legal boundaries.

Module	Details	Hrs.
	Course Introduction This course provides a comprehensive introduction to the principles, practices, and legal frameworks of cyber security. Students will explore various types of cybercrimes, attack methodologies, and defensive strategies, with a strong emphasis on legal and regulatory compliance. The course covers Indian cyber laws and compliances, including the IT Act 2000 and its amendments, as well as global security standards. Through theoretical insights, learners will be equipped to identify, analyse, and respond to cyber threats within a legal and ethical context.	**01**
01.	**Introduction to Cybercrime**	**5-6**
	Contents: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	
02.	**Cyber offenses & Cybercrime**	**7-8**
	Contents: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	
03.	**Tools and Methods Used in Cyberspace**	**7-8**
	Contents: Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
04	**The Concept of Cyberspace**	**7-8**
	Contents: The Concept of Cyberspace, E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange, Law Relating to Electronic Banking, The Need for an Indian Cyber Law.	
05	**Indian IT Act**	**5-6**
	Contents: Cyber Crime and Criminal Justice, Penalties under the IT Act, 2000, Adjudication Mechanism, Appeals under the IT Act, Information Technology Act, 2000, IT Act, 2008 and its Amendments.	
06	**Information Security Standard compliances**	**4-5**
	Contents: SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	
	Course Conclusion	

	This course equips learners with essential knowledge of cybercrime, cybersecurity practices, and cyber laws governing the digital ecosystem. Students gain an understanding of the Indian IT Act and its amendments, various aspects of cyber law, cybercrime investigation and adjudication processes, and major information security compliance standards. Overall, the course enables learners to analyze cyber threats, interpret legal and regulatory requirements, and apply security and compliance principles for secure and lawful use of information systems.	**01**
	Total	**45**

Course Outcomes: A learner will be able to –

1. Classify various types of cybercrimes, cyber threats, and attack techniques, and analyze their technical and societal impacts in digital environments.
2. Analyze cyberattack scenarios and security challenges to identify vulnerabilities, attack vectors, and appropriate technical and organizational security measures.
3. Interpret and apply provisions of the Indian Information Technology Act, 2000 and its amendments to address cybercrime investigation, adjudication, and legal issues.
4. Analyze different aspects of cyber law, including cyberspace governance, e-commerce, digital contracts, intellectual property, electronic evidence, and criminal liability.
5. Apply cybersecurity, legal, and compliance knowledge to real-world scenarios to recommend lawful, secure, and compliant practices in the design and use of information systems.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OCE7016.1	3	-	-	-	-	-	-	-	-	-	-
OCE7016.2	3	3	3	3	3	-	-	-	-	-	3
OCE7016.3	3	3	-	-	-	-	-	-	-	-	-
OCE7016.4	3	3	-	-	-	-	-	-	-	-	-
OCE7016.5	3	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**

Text Books:

1. Nina Godbole, Sunit Belapure, “Cyber Security”, Wiley India, New Delhi.
2. “The Indian Cyber Law” by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3. “The Information technology Act, 2000”; Bare Act- Professional Book Publishers, New Delhi.

Reference Books:

1. “Cyber Law & Cyber Crimes” By Advocate Prashant Mali; Snow White Publications, Mumbai.
2. William Stallings, “Cryptography and Network Security”, Pearson Publication.

3. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.

Other Resources:

1. The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2. A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer professionals-33538

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

One MCQ test as per GATE exam pattern/ level: 05 marks.

One Class test: 05 Marks

One 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%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
OEC	OEC7017	Digital Business Management	03

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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solution
4. PO5: Modern tool Usage
5. PO7: Ethics

Course Objectives:

1. To familiarize students with fundamental concepts, models, and transformation drivers that define digital business ecosystems.
2. To convey strategic frameworks, digital roadmaps, organizational readiness, and performance metrics used in digital transformation.
3. To explain key digital marketing techniques, customer acquisition methods, automation tools, and attribution models.
4. To provide understanding of ecommerce and Omni channel operations, including platforms, logistics, payments, and customer service systems.
5. To develop competency in data-driven decision-making, analytics tools, dashboards, SQL basics, and AI applications in business.
6. To familiarize with platform business models, API integrations, agile/lean product development, and ethical, legal, and security considerations in digital environments.

Module	Details	Hrs.
	Course Introduction Digital Business Management focuses on how digital technologies transform traditional business systems, processes, and decision-making. This course introduces foundations of digital business, digital strategy, marketing, ecommerce, data analytics, platforms, and product delivery, emphasizing the differences between traditional and digital business models. With growing reliance on cloud platforms, analytics, AI, and Omni channel systems, engineering graduates must understand how technical solutions enable digital transformation and value creation. The course equips with managerial and	**01**

	analytical perspectives required to design, evaluate, and manage technology driven business solutions in modern digital enterprises.	
01.	**Foundations of Digital Business** **Contents:** Introduction to Digital Business: Definition and scope Key terminology: digitization, digitalization, transformation Traditional vs Digital Business Models Digital Transformation Drivers Digital Maturity & Culture Digital Business Models – Marketplaces, Subscription, Freemium, PaaS, Value Chains Network Effects & Customer Experience	**06-08**
02.	**Digital Strategy & Transformation** **Contents:** Strategy Frameworks for Digital Initiatives Organizational Change & Governance Digital Roadmap Development Digital Leadership skills: innovation, risk-taking, cross-functional alignment Metrics for Digital Success (Engagement, Retention, Lifetime Value, Customer Acquisition Cost) KPI Dash boarding & Review	**06-08**
03.	**Digital Marketing & Customer Acquisition** **Contents:** Digital Marketing Fundamentals Search Engine Optimization & Search Engine Marketing Basics Social Media & Influencer Marketing Content Marketing & Campaign Design Customer Journey Mapping Personalization & CRM Tools Attribution Models & Optimization Campaign optimization: A/B testing basics	**06-08**
04.	**Ecommerce & Omni channel Operations** **Contents:** Ecommerce Models (B2B, B2C, C2C, D2C) Payments, Fulfilment, Returns, Last-mile Logistics Omni channel Commerce Inventory Visibility & Order Management Digital Customer Service Tools Platform Selection & vendor Evaluation	**06-08**
05.	**Data, Analytics & AI for Business** **Contents:** Data-driven Decision Making Data Pipelines & SQL Basics Descriptive & Diagnostic Analytics Predictive Analytics Recommendation Engines KPI Dashboards (Tools)	**07-09**

	Communicating Data Insights	
06.	**Platforms, Ecosystems, Product Delivery & Ethics**	**06-08**
	Contents: Platform Business Models & Ecosystems Product Management Basics Agile & Lean Startup API Economy & Partnerships Ethical, Legal & Security Considerations	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: A learner will be able to -

1. Summarize the fundamental concepts, models, transformation drivers and customer experience elements of digital business.
2. Analyse the digital strategies, organizational reediness, transformation plans & business performance metrics to evaluate digital initiatives.
3. Apply digital marketing, customer acquisition methods, automation tools, and attribution techniques to develop data driven marketing insights.
4. Classify ecommerce and omnichannel models, evaluate digital platform, and analyse operational workflow to propose process improvements.
5. Use analytical tools, dashboards, SQL fundamental and AI concepts to interpret business data and communicate insights effectively.
6. Analyse platform ecosystem, select product development methodologies, interpret API based integrations and identify ethical/ legal concerns in digital system.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7017.1	3	3	-	-	-	-	-	-	-	-	-
OEC7017.2	3	3	3	-	-	-	-	-	-	-	-
OEC7017.3	-	3	3	-	3	-	-	-	-	-	-
OEC7017.4	-	3	-	-	3	-	-	-	-	-	-
OEC7017.5	-	3	-	-	3	-	3	-	-	-	-
OEC8028.6	-	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**

Text Books :

1. K. C. Laudon and J. P. Laudon, Management Information Systems: Managing the Digital Firm, latest ed. Harlow, U.K.: Pearson Education.
3. D. L. Rogers, The Digital Transformation Playbook: Rethink Your Business for the Digital Age, New York, NY, USA: Columbia Business School Publishing, 2016.
K. Sandeep & J. J. Jose, Digital Business Management, Himalaya Publishing House.
4. A. Osterwalder and Y. Pigneur, Business Model Generation, Hoboken, NJ, USA: Wiley, 2010.
5. E. Brynjolfsson and A. McAfee, The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, New York, NY, USA: W. W. Norton & Company, 2014.
6. P. Kotler, H. Kartajaya, and I. Setiawan, Marketing 5.0: Technology for Humanity, Hoboken, NJ, USA: Wiley, 2021.

Reference Books :

1. T. Eisenmann, G. Parker, and M. Van Alstyne, Platform Revolution: How Networked Markets Are Transforming the Economy, New York, NY, USA: W. W. Norton & Company, 2016.
2. R. T. Rust, M.-H. Huang, and S. J. Lin, Service Analytics and Digital Transformation, Springer, Cham, Switzerland, 2019.
3. S. Sharda, D. Delen, and E. Turban, Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th ed. Boston, MA, USA: Pearson, 2020.
4. M. Porter and J. Heppelmann, How Smart, Connected Products Are Transforming Companies, Boston, MA, USA: Harvard Business Review Press, 2015.
5. A. Chaffey and F. Ellis-Chadwick, Digital Marketing: Strategy, Implementation and Practice, 8th ed. Harlow, U.K.: Pearson Education, 2022.

Other Resources :

1. Digital Business – IIT Kharagpur (Prof. S. Ray) NPTEL Course – Highly aligned with Digital Strategy, Platforms, Digital Models.
2. Marketing Management – IIT Roorkee / IIT Kanpur (Digital marketing modules included) Covers customer journey, campaigns, analytics basics.
3. Introduction to Industry 4.0 and Industrial Internet of Things – IIT Kharagpur Useful for Module 1 (Digital Transformation Drivers).

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested break up of distribution:

a) Activities/Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)
Mid semester examination will be based on 40% to 50% syllabus.

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
OEC	OEC7018	Energy Audit And Management	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: NIL

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: Life-long learning

Course Objectives:

1. To understand the importance of energy security in achieving sustainable development and to learn the fundamental principles of energy conservation.
2. To introduce performance evaluation criteria for electrical and thermal installations to support effective energy management.
3. To utilize data obtained from performance evaluations to identify and prioritize energy-saving measures.

Module	Details	Hrs.
	Course Introduction Energy is a critical resource for economic growth, industrial productivity, and sustainable development. With rising energy costs, increasing demand, and growing environmental concerns, efficient use of energy has become essential across all sectors. Energy Audit and Management focuses on the systematic evaluation, monitoring, and optimization of energy consumption to improve efficiency, reduce operating costs, and minimize environmental impact. This course introduces the principles and practices of energy management, including energy auditing techniques, energy efficiency measures, and the use of modern tools for energy analysis. Students will learn how to assess energy usage in industrial, commercial, and residential facilities, identify energy-saving opportunities.	**01**
01.	**Energy Scenario**	**5-7**
	Contents:	
	Primary and Secondary Commercial and non- commercial energy Renewable and Non Renewable Energy, Present Global and Indian Energy Scenario, Energy Security, Energy Conservation and its	

	Importance, Energy efficiency benefits. Energy Conservation Act-2001 and its Features. Schemes of BEE under EC Act-2001.	
02.	**Energy Audit Principles:**	**8-10**
	Contents: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments. Elements of monitoring& targeting, benefits of M&T; Data and information-analysis. Investment need, Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	
03.	**Energy Management and Energy Conservation in Electrical System:**	**9-11**
	Contents: Basics of Electrical Energy, power factor, Motor loading calculations, relationship between power, voltage and current. Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, harmonics. Energy efficiency measures in lighting system, lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers, General energy saving opportunities in lighting system, Energy conservation opportunities in induction motors, Energy efficient motors, Motor retrofitting, soft starters, variable speed drives. Case studies based on P.F improvement, EEM, Lighting system	
04.	**Energy Management and Energy Conservation in Thermal Systems:**	**9-11**
	Contents: Thermal Energy basics, specific heat, sensible heat, latent heat, energy content in fuel, Heat transfer basics Energy unit and conversions. Review of different thermal loads: Boiler System, performance evaluation of boilers, energy conservation opportunities in boiler Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, efficient steam utilization and energy saving opportunities. Characteristics of efficient furnace, performance evaluation of a typical fuel fired furnace, general fuel economy measures in furnaces Need and benefits of insulation, simplified formula for heat loss calculation, Purpose of heat exchanger, LMTD HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and energy savings opportunities.	

	Case Studies based on boiler, furnace and insulation	
05.	**Energy Performance Assessment:**	**3-5**
	Contents: On site Performance evaluation techniques, Energy performance assessment and its improvement: lighting system, Installed Load Efficacy Ratio (ILER) method, Motor, Heat Exchanger-LMTD, Boiler and Furnace.	
06.	**Energy conservation in Buildings:**	**3-5**
	Contents: Energy Conservation Building Codes (ECBC), ECBC guidelines on HVAC system, lighting system, Electric power, energy efficiency measures in buildings, Energy performance assessment of buildings, Green Building.	
	Course Conclusion This course provides a comprehensive understanding of energy auditing principles and energy management practices. Learners gain knowledge of energy consumption patterns, audit methodologies, and energy performance evaluation techniques for electrical and thermal utilities. The course emphasizes the identification of energy conservation opportunities, and implementation of energy-efficient technologies.	**01**
	Total	**45**

Course Outcomes :

1. Understand global and Indian energy scenario, Energy Conservation Act-2001, ECBC guidelines, to promote energy-efficient and sustainable buildings.

2. Conduct energy audits, analyse energy performance, identify energy-saving opportunities, and evaluate the financial feasibility of energy conservation measures.

3. Apply energy efficiency measures in lighting and motor systems, improve power factor, and identify practical energy conservation opportunities through case studies.

4. Apply energy-saving opportunities in boilers, furnaces, steam distribution, insulation, and HVAC systems, and practical solutions through case studies to improve energy efficiency.

5. Analyse the energy performance of lighting, motors, boilers, furnaces, and heat exchangers on-site and recommend effective energy-saving improvements.

CO-PO mapping table with correlation level:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7018.1	3	-	-	-	-	3	-	-	-	-	-
OEC7018.2	3	3	-	3	-	3	-	-	-	-	3
OEC7018.3	3	-	-	-	-	-	-	-	-	-	-
OEC7018.4	3	-	-	-	-	-	-	-	-	-	-
OEC7018.5	-	3	-	-	-	3	-	-	-	-	3
Average	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**

Text Books:

1. General Aspects of Energy Management and Energy Audit, BEE, Fourth Edition,2015
2. Energy Efficiency in Thermal Utilities, BEE, Fourth Edition,2015
3. Energy Efficiency in Electrical Utilities, BEE, Fourth Edition,2015
4. Energy Performance Assessment for Equipment and Utility Systems, BEE, Fourth Edition,2015

Reference Books:

1. Handbook of Electrical Installation Practice, by Geoffrey Stokes, Blackwell Science, 4th Edition
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Web References:

1. http://www.bee-india.nic.in/
2. https://nceexam.in/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. **Continuous Assessment (20 Marks)**
   - 01 MCQ test: 05 Marks
   - 01 Class test: 10 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
OEC	OEC7019	Development Engineering	03

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

Pre-requisite: NIL

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Module	Details	Hrs
	Course Introduction	**01**
01.	**Introduction to Rural Development**	**8-10**
	Contents: Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
02.	**Post-Independence rural Development**	**4-6**
	Contents: Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
03.	**Rural Development Initiatives in Five Year Plans**	**6-8**

	Contents: Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
04.	**Post 73rd Amendment Scenario**	**4-6**
	Contents: 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	
05.	**Values and Science and Technology**	**10-12**
	Contents: Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	
06.	**Ethics**	**3-5**
	Contents: Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7019.1	-	-	-	-	-	3	-	-	-	-	-
OEC7019.2	-	-	-	-	-	3	-	-	-	-	-
OEC7019.3	-	-	-	-	-	3	-	-	-	-	-
OEC7019.4	-	-	-	-	-	3	-	-	-	-	3
OEC7019.5	-	-	-	-	-	3	3	-	-	-	-
OEC7019.6	-	-	-	-	-	3	3	-	-	-	3
Average	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**3**

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
LC	EELBC710	Electrical System Design and Audit Lab	01

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

Pre-requisite:

1. ESC102- Basic Electrical Engineering
2. EEPCC408 Power System Engineering
3. EEPCC509 Electrical Machines
4. EEPCC510 Protection and Switchgear

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO6: The Engineer and The World
5. PO8: Individual and team work
6. PO9: Communication
7. PO10: Project management and finance
8. PO11: Life-long learning

Course Objectives:

1. To comprehend various electrical drawings and their application in electrical projects
2. To comprehend design of distribution substation and selection/sizing of cable and other auxiliary systems
3. To study data information analysis techniques and electrical load management techniques to apply in Energy audit project.
4. To study various energy efficient technologies and their applications in electrical installations

Module	Details	Hrs
	Course Introduction Electrical system design is an important aspect of an electrical installation. It deals with safety, reliability, compliance, efficiency, future proofing, cost effectiveness and sustainability in the electrical system design across various electrical installations. Electrical system auditing plays a crucial role in ensuring energy efficiency, cost savings, safety, reliability documentation, and continuous improvement in electrical systems.	
01.	**Introduction to Institute Electrical Installation**	**06**
	Learning Objective: *To impart the knowledge of different electrical drawings used in electrical projects and different equipment used in distribution substation and apply the acquired skill to develop single line diagram of their own house.*	
	Theme for conducting experiment: **1.** Demonstration of Single line diagram of our institute power distribution network and other electrical drawings used in the electrical installation such as Panel drawing, lighting and power plans. ***Learning Outcomes:*** *A learner will be able to*	

	LO1.1: Identify various components of electrical drawings such as single line diagram, panel drawings, lighting plan, Bill of Quantities and recognize their specifications at professional level in an electrical projects. (PI-2.2.2, 2.4.4, 9.1.1, 9.1.2, 11.1.1, 11.3.1)	
	Theme for conducting experiment: **2.** Visit to Institute Electrical Distribution Substation, Electrical LT panel room etc. and identify various electrical system and protection equipment in the substation. (report based on the substation Visit) ***Learning Outcomes:*** *A learner will be able to* *LO1.2: Identify various electrical system and protection equipment in the substation and describe their engineering roles towards the protection of the public and produce well-structured engineering report (PI-2.1.2, 6.1.1, 9.1.2,9.3.1)*	
02.	**Design of Distribution Substation**	**06**
	Learning Objective: *To impart knowledge and skill required for the selection and sizing of distribution transformer, feeder, other metering and protection equipment in the distribution network.*	
	Theme for conducting experiment: **1.** Design of a distribution transformer and metering and protection devices and develop single line diagram of given power distribution network. ***Learning Outcomes:*** *A learner will be able to* *LO2.1: Identify various components of a power distribution network and determine design objectives to arrive at their specifications referring to the protection of public and safety and reframe the network in the form of well-structured SLD. (PI-2.1.2, 2.2.1, 3.1.4, 3.1.6, 6.1.1, 9.1.2, 9.3.1, 11.1.1)*	
	Theme for conducting experiment: **2.** Design of underground cables as a feeder for the given power distribution network. ***Learning Outcomes:*** *A learner will be able to* *LO2.2: Explore and synthesize engineering requirements of underground cable design and determine their design objectives for a given power distribution network and arrive at their specifications referring to the protection of public and safety. (PI-3.1.4, 3.1.6, 6.1.1, 9.1.2, 11.1.1)*	
03.	**Data Information Analysis and Energy Audit**	**10**
	Learning Objective: *1. To impart the knowledge of data information analysis techniques to apply and analyse energy performance of the given electrical installation.* *2. To teach the methodology to conduct Energy Audit and apply the skill acquired to conduct energy audit in any electric utility in the institute*	
	Theme for conducting experiment: **1.** Analyze the energy performance of the given electrical installation using CUSUM analysis technique. ***Learning Outcomes:*** *A learner will be able to* *LO3.1: Represent the energy data in a graphical form and analyze the data for trends and correlations using data information analysis techniques to reach to an appropriate conclusions about the energy performance of the plant. (P.I.- 4.3.2, 4.3.3, 4.3.4, 6.3.2, 9.1.2, 11.1.1)*	
	Theme for conducting experiment: **2.** Analyze the performance of different induction motors. ***Learning Outcomes:***	

	A learner will be able to *LO 3.2: Design and develop experimental approach to measure the different physical quantities and analyze the performance of electrical installation. (PI- 4.2.1, 8.1.1, 9.1.2, 11.1.1)*	
	Theme for conducting experiment: ***3.*** Conduct the energy audit of anyone electrical installations in the campus. (Class room, Lift, Seminar hall, Canteen etc.) ***Learning Outcomes:*** *A learner will be able to* *LO 3.3: Design and develop experimental approach and apply appropriate instrumentation to conduct energy audit of electrical installations and synthesize information to reach to the appropriate conclusions. (PI- 4.1.3, 4.2.1,4.3.4, 6.3.3, 8.1.1, 9.1.2, 11.1.1)*	
04.	**Energy Efficient Technologies** ***Learning Objective:*** *To convey the skill required to identify energy efficient technology for the given electrical installation and analyze its effectiveness on the economical basis.*	**08**
	Theme for conducting experiment: **1.** Case study of analyzing the economics of Power Factor Improvement for a given installation and its impact towards reduction in commercial electricity bill. ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Determine the design objectives to select appropriate target power factor for the power factor improvement of the given electrical installations based on the energy optimization and Techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.1)*	
	Theme for conducting experiment: **2.** Case study of analyzing the effectiveness of TOD tariff towards implementing effective load management and reducing Energy Bill. ***Learning Outcomes:*** *A learner will be able to* *LO 4.2: Analyze commercial electricity bills if an electrical installation and decide appropriate load shifting to a different time slot and analyze its effectiveness on the basis of energy bill optimization with techno-economic considerations. (P.I.-3.2.3, 6.3.1, 9.1.2,10.2.1, 11.1.1, 11.3.2)*	
	Theme for conducting experiment: **3.** Case study of analyzing the effectiveness of Motor retrofit Program towards achieving energy efficiency in the given electrical installations. ***Learning Outcomes:*** *A learner will be able to* *LO 4.3: Determine the design objectives to select appropriate standard motor or energy efficient motor based on energy optimization and Techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.1)*	
	Theme for conducting experiment: **4.** Case study of comparing Energy Efficient Lighting Design (EELD) with Standard lighting design in terms of Lighting Power Density. ***Learning Outcomes:*** *A learner will be able to* *LO 4.4: Determine the design objectives to select appropriate lighting system for the given electrical installation based on energy optimization and techno-economic considerations. (P.I.-3.1.6, 6.3.2, 9.1.2, 10.2.1, 11.1.)*	
	Minimum 2 experiments from each module and total 8 experiments	

Performance Indicators:

P.I. No.	P.I. Statement
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.2.1	Reframe complex problems into interconnected sub-problems
2.2.2	Identify, assemble and evaluate information and resources.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
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
4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
4.3.2	Analyse 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
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 global, regional and local level
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
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.
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
10.2.1	Analyse and select the most appropriate proposal based on economic and financial considerations.
11.1.1	Describe the rationale for the requirement for continuing professional development.
11.3.1	Source and comprehend technical literature and other credible sources of information
11.3.2	Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes:

Learner will be able to

1. **Identify and Analyse** different electrical drawings used in an electrical project and **produce** technical report on Institute substation visit. *(LO1.1)*
2. **Identify and analyse** the design objectives of distribution substation and **determine** their specifications and **develop** single line diagram. *(LO2.1, 2.2)*
3. **Apply** data information analysis techniques to **conclude** the energy performance of the plant and conduct the energy audit of an existing electrical installations and **analyse** its performance *(LO3.1, 3.2, 3.3)*
4. **Determine** the design objectives **to select** appropriate energy efficient technologies on techno-economic basis to **apply** in the given electrical installation. *(LO4.1, 4.2, 4.3, 4.4)*

CO-PO mapping table with correlation level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
EELBC710.1		3				3			3		3
EELBC710.2		3	3			3			3		3
EELBC710.3				3		3		3	3		3
EELBC710.4			3			3			3	3	3
Average		3	3	3		3		3	3	3	3

Text Books:

1. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000
2. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
3. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
4. Energy Management Handbook, by W.C. Turner, John Wiley and sons
5. Handbook on Energy Audits and Management‖, by Amit Kumar Tyagi, TERI
6. General Aspects of Energy Management and Energy Audit, Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE
7. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press
8. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
9. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.

Reference Books:

1. Medium Voltage technical guide, Basics for MV design according to IEC and IEEE standards, by Schneider Electric.
2. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010.
3. Energy Auditing Made Simple‖, by P. Balasubramanian, Seperation Engineers (P) Ltd.
4. Energy Management Principles, by C.B. Smith, Peragamon Press.
5. Energy Efficiency in Electric Utilities Guidebook for National Certification Examination for Energy Managers and Energy Auditors by BEE.

Other Resources:

1. http://www.bee-india.nic.in/
2. NPTEL Video Course : NOC: Electrical Distribution System Analysis http://www.digimat.in/nptel/courses/video/108107112/L04.html

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Practical Exercises- 10 Marks
- Oral Test– 05 Marks
- Regularity and active participation - 05 Marks
- **Institute Substation Visit:** Students' visit to the Institute Power Distribution Substation to observe various Protection equipment, overall power flow in the system. It also includes visit to one of the LT panel room, one of the floor power distribution, UPS power panel. All students shall submit visit report in appropriate format as a part of the submission (05 marks)

END SEMESTER ASSESSMENT (Oral Examination) (25 Marks)

- Students will be appearing for Oral examination in front of both Internal and External examiners. Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LC	EELBC711	Applied Power Electronics Laboratory	01

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

Pre-requisite:

1. EEPCC407 Power Electronics
2. EELBC403 Power Electronics Laboratory

Program Outcomes addressed:

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

Course Objectives:

1. To provide hands-on skill-sets to design, model and implement the power electronics systems/ subsystems
2. To impart knowledge on practical aspects of power electronics converters design.
3. To impart the knowledge designing power converters for real life applications

Module	Details	Hrs
	Course Introduction Electrical engineering students should be adequately acquainted with the practical knowledge of Power Electronics converters, design, modelling and control implementation. Most of the engineering domains need some or other form of power converters. So knowledge of modelling, simulation, emulation, and H/W implementation is essential from Electrical engineering perspective. This course aims at imparting such knowledge through such tasks leading to the achievement of proficiency in Power Electronics domain	
01.	**Design of Power Electronics Converter Hardware**	**06**
	Learning Objective: ***To impart the skill of handling power electronics components and their use in various converters with modelling and closed loop control implementation as a team***.	
	Theme for conducting experiment/simulation: **1.** Implementation of a Buck or Boost or Buck-Boost DC-DC converter (any one converter) and its auxiliary circuits. Model and design of feed-back compensator for closed- loop control of the selected DC-DC converter fed from suitable energy source (any one converter) ***Learning Outcomes:*** *A learner will be able to* *LO 1.1:* Collaboratively design / implement hardware of DC –DC Converter to analyze it steady state / transient operations, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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) **2.** Implement a single-phase bridge inverter for an AC load. Model and design a feed-back compensator for a single-phase bridge inverter	

	Learning Outcomes: *A learner will be able to* *LO 1.2:* Collaboratively design / implement hardware of DC–AC Converter to analyze it steady state / transient operations, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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) **3.** Model and design a feedback compensator for a flyback or a suitable converter (SMPS) for auxiliary supply requirement/for LED lighting system / or any other application. Implement any power electronic converter for a specific application. ***Learning Outcomes:*** *A learner will be able to* *LO 1.3:* Collaboratively design / implement hardware/ simulate SMPS for a specific selected application, apply appropriate testing procedures, ensure safety precautions, collect and represent data 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.	**Design of Power Electronics Converter Control (Programming)**	**08**
	Learning Objective: ***To develop skill to program / code the control algorithms for power electronics converters as a team***	
	Theme for conducting experiment: **4.** Implement single phase or three phase SPWM technique for control of bridge inverter for an AC load. ***Learning Outcomes:*** *A learner will be able to* *LO 2.1:* 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, 8.1.1, 8.1.2, 11.3.1, 11.3.2) **5.** Implementation of microcontroller / DSP code for voltage mode control (VMC) of DC-DC converter. Implementation of microcontroller / DSP code for current mode control (CMC) of DC-DC converter ***Learning Outcomes:*** *A learner will be able to* *LO 2.2:* Demonstrate the ability to design, develop, and implement microcontroller/ DSP programs for a given converter using appropriate software platforms, instructions, and programming techniques to meet technical and operational requirements for the closed loop control 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) **6.** Implementation of microcontroller / DSP code for VMC/ CMC of an inverter. Implementation of microcontroller / DSP code for v/f control of induction motor / any other drive application ***Learning Outcomes:*** *A learner will be able to*	

	LO 2.3: Demonstrate the ability to design, develop, and implement microcontroller/ DSP programs for a given converter using appropriate software platforms, instructions, and programming techniques to meet technical and operational requirements for the closed loop control 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)	
03.	**Design of Auxiliary Systems for Power Electronics Applications**	**06**
	Learning Objective: ***To acquire skill to design, implement simulate the auxiliary subsystems, protection and safety in the power electronics applications.***	
	Theme for conducting experiment: **7.** Design of Gate driver circuits for different power semi-conductor switches (Si devices or Wide band gap devices like SiC or GaN etc.) **8.** Design of snubber circuit and analysing its impact on the operation of switch used in PE converter or inverter **9.** Design of heat sink for a PE converter and verify its thermal performance. **10.** Design AC/DC voltage and Current Sensing (isolated/ or non-isolated) circuit for feedback control of a PE converter **11.** Design of over current / short circuit protection system for any PE converter ***Learning Outcomes:*** *A learner will be able to* *LO 3.1:* Design, implement/ simulate and test the power electronic subsystems using suitable platforms, execute experiments, assess performance, and correlate results with expectations. (P.I.- 2.1.2, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2, P.I.- 8.1.1, P.I.-11.3.1, P.I.-11.2.2)	
	Minimum 2 experiments from each module and Industrial visit	

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
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
4.1.1	Define a problem, its scope and importance for purposes of investigation
4.1.4	Establish a relationship between measured data and underlying physical principles
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
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.
8.1.1	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 power electronics components and their assembly into a particular power topologies using technical literature *(LO1.1, LO1.2, LO1.3).*
2. Apply programming skill to implement control algorithms using suitable software tool for a given power converter *(LO2.1, LO2.2, LO2.3).*
3. Integrate and interface components and subsystems used in power electronics applications. *(LO 3.1).*

CO-PO mapping table with correlation level:

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			3
EELC506.3		3		3	3			3			
Average		3		3	3			3			3

Text Books:

1. 1. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi. 2. L. Umanand, Bhatt, "Design of Magnetic Components for Switched Mode Power Converters", John Wiley & Sons

Other Resources:

1. 1. NPTEL course: Design of Power Electronic Converters, Prof. Shabari Nath, IIT Guwahati.
   2. NPTEL course: Advanced Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee

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 power electronics domain. 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
MJP	MJP701	Major Project-A	02

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 and Collaborative Teamwork
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-Long learning

Course Objectives

1. To motivate students to review the knowledge and skills they acquired during their program.
2. To ensure students can analyze a specific problem or issue, and they can demonstrate proficiency in project design, research methods application, data collection and analysis, and results presentation.
3. To foster self-learning and research skills.

Course Outcomes:

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

1. Identify and define a problem of societal or research relevance through a comprehensive literature review and a detailed problem analysis.
2. Apply appropriate engineering principles, analytical methods, and modern tools to design feasible and effective solutions for the identified problem.
3. Conduct investigations using suitable research methodologies, data collection, and analysis techniques to validate the proposed solution.
4. Evaluate the proposed solution considering societal, environmental, and ethical aspects to ensure sustainable engineering practices.
5. Demonstrate effective teamwork, project management, and communication skills in preparing and presenting project outcomes.
6. Engage in self-directed learning and continuous improvement to enhance technical competence and professional growth.

A. Guidelines for the Major Project-A

Guidelines

1. Project Topic Selection and Allocation

- Towards the end of Semester VI, students will be introduced to potential project domains and problem areas.
- Project topics must be finalized in consultation with the guide, ensuring technical feasibility and alignment with the guide's domain expertise.

- Students should refer to recent research papers (preferably from IEEE, Elsevier, ACM, or similar sources) not older than three years.
- Students are encouraged to propose original ideas, including problem statements inspired by Digital India initiatives, Smart India Hackathon (SIH), and other innovation platforms.

Criteria for Topic Finalization:

- Novelty: The work should introduce new contributions or address clear gaps in existing systems.
- Technological Relevance: Use of current and emerging tools, platforms, methods, and technologies.
- Originality: Avoid repetition of projects undertaken in the past three years.
- Product Orientation (Preferred): Solutions that can evolve into a deployable product or prototype.

Project Team & Execution:

- Each group must consist of 3–4 students (within the same or across departments).
- Projects may be executed internally or in collaboration with industry, research organizations, or external agencies.
- Guides will be allotted to monitor progress, review weekly work, and maintain attendance and log records.
- Topic proposals will be reviewed domain-wise, and final approval will be given by the HoD and the project coordination committee.

2. Project Progress Monitoring

- Each department shall constitute a Project Progress Monitoring Committee.
- Minimum two formal progress presentations must be conducted during the semester.
- Internal guides may coordinate with industry/external partners for off-campus project supervision if required.

3. Project Report Format

The final report should follow the institute guidelines and include:

1. Abstract
2. Introduction
3. Literature Review / Existing System
4. Research Gap / Limitations
5. Problem Statement and Objectives
6. Proposed System
    - Analysis / Algorithm / Framework
    - Design Methodology
7. Experimental Setup
    - Input Data / Dataset Details
    - Software and Hardware Specifications
    - Evaluation Parameters
8. Results and Discussion
9. Conclusion and Future Scope
10. References
11. Appendices (if applicable: Certificates, Publications, etc.)

Students are encouraged to complete relevant certification courses that support the technical requirements of their project.

B. In-Semester Continuous Assessment (Evaluation)

Total Marks: 50 (Semester VII)

Component	Description	Marks
Topic Approval Presentation	Evaluation by Project Monitoring Committee	10
Mid-Semester Progress Presentation	Demonstration of progress in methodology and implementation	15
Final Report & Presentation	Quality of report, implementation, teamwork, and final demonstration	20
Regularity and active participation	Consistent attendance, timely submission of weekly progress logs, proactive involvement in group discussions, task ownership, and meaningful contribution to project development throughout the semester.	05

Quality Evaluation Parameters

- Relevance and quality of the problem selected
- Clarity in problem definition, objectives, and scope
- Originality and relevance to current industry/research trends
- Quality of system design, methodology, and implementation
- Clarity, organization, and technical depth of the report
- Effectiveness of oral presentation
- Individual contribution and teamwork

Course Type	Course Code	Course Name	Credits
HSS	HSS703	Financial Planning	02

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO6: The Engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. Develop a foundational understanding of financial principles and their relevance to personal financial planning
2. Enhance analytical skills to assess financial situations and propose effective solutions.
3. Acquire practical financial management skills through budgeting, investment analysis, and debt management
4. Foster ethical and responsible financial behaviour in alignment with professional standards and societal values

Module	Details
01.	**Setting Financial goals, Budgeting & cash flow management** Understanding financial goals: short, medium, long-term, and setting them using the SMART criteria, Introduction to budgeting: covering income, expenses, savings, and investments, Budgeting techniques: zero-based budgeting, envelope system, and the 50/30/20 rule, Cash flow management strategies for maintaining financial stability.
02.	**Saving Strategies & Investments, Borrowing & Credits** Importance of saving and investing for financial growth, Introduction to different types of savings accounts and investment options, Understanding the risk-return tradeoff in investing, Diversification and asset allocation strategies, Responsible borrowing practices and managing debt, Credit management: credit scores, types of credit, and building good credit history.
03.	**Risk Management** Concept of financial risk and its implications, Types of financial risks: market risk, inflation risk, interest rate risk, credit risk, Introduction to insurance: types of insurance (life, health, property, auto), coverage options, Importance of emergency fund and risk mitigation strategies Evaluating risk tolerance and creating a risk management plan
04.	**Income tax Fundamentals** Basics of income tax: taxable income, tax deductions, tax credits, Understanding tax brackets and marginal tax rates, Types of taxes: income tax, payroll tax, capital gains tax, Filing tax returns: forms, deadlines, filing options, Tax-saving strategies: deductions, credits, retirement accounts
05.	**Waste management & recycling** Solid Waste Management: Collection, Treatment, Disposal, Recycling Processes and Technologies, E-waste Management and Hazardous Waste Handling, Circular Economy Principles, Waste Reduction Strategies: Source Reduction, Reuse, Repair

06.	**Environmental Impact Assessment** Introduction to Environmental Impact Assessment (EIA), EIA Process: Screening, Scoping, Impact Assessment, Mitigation, Monitoring, Methods and Tools for Impact Assessment: GIS, LCA, Risk Assessment, Case Studies of EIA in Various Sectors: Infrastructure, Energy, Mining, Construction, Role of Stakeholders in EIA Process
Total no. of hours: **30**	

Course Outcomes:

1. Demonstrate a comprehensive understanding of financial concepts
2. Analyze complex financial scenarios, identify financial challenges, and propose effective strategies to achieve financial goals.
3. Apply financial planning principles and techniques to develop personalized financial plans aligned with individual goals and circumstances.
4. Utilize financial tools, software applications, and online resources proficiently
5. Adhere to ethical standards and professional codes of conduct in financial decision-making
6. Recognize the societal impact of financial decisions and promote responsible financial behavior

Text Books :

1. Personal Finance by Jeff Madura and Hardeep Rai, Pearson Education
2. Financial Management: Principles and Applications, by Sheridan Titman, Arthur J. Keown, and John D. Martin, Pearson Education
3. Project Management: The Managerial Process, by Erik W. Larson and Clifford F. Gray, McGraw-Hill Education

Reference Books :

1. The Total Money Makeover: A Proven Plan for Financial Fitness, by Dave Ramsey, Thomas Nelson
2. Investing 101: From Stocks and Bonds to ETFs and IPOs, an Essential Primer on Building a Profitable Portfolio, by Michele Cagan , Adams Media
3. Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk, by Steve L. Allen (Publisher: Wiley)

Other Resources:

1. NPTEL Course: Behavioral And Personal Finance, By Prof. Abhijeet Chandra, Vinod Gupta School of Management, IIT Kharagpur :-Web link- https://onlinecourses.nptel.ac.in/noc24_mg07/preview
2. NPTEL Course: Financial Management, By CA Amita Bissa, Jai Narain Vyas University, Jodhpur:- Web link- https://onlinecourses.swayam2.ac.in/cec20_mg05/preview

Course Type	Course Code	Course Name	Credits
OEC	OEC8021	Project Management	03

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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO9: Communication
6. PO10: Project Management and Finance
7. PO11: Life-long learning

Course Objectives:

1. To familiarize students with fundamental project management concepts, frameworks, tools, and standard terminology relevant to engineering projects.
2. To enable students to analyze project requirements and apply systematic project selection techniques and portfolio management approaches for informed decision-making.
3. To enable students to plan projects effectively by developing work breakdown structures, schedules, budgets, and comprehensive risk management plans.
4. To equip students to monitor and control project progress using quantitative performance measurement techniques, including Earned Value Management.
5. To evolve students' leadership, communication, ethical awareness, and technical documentation skills necessary for effective project execution and formal project closure.

Module	Detailed Contents	Hrs
	Course Introduction In today's technology-driven and highly competitive engineering environment, effective project management has become critical for delivering complex projects within defined time, cost, quality, and resource constraints. Rapid technological advancements, multidisciplinary teams, and increased stakeholder expectations demand a structured approach to planning, execution, monitoring, and control of projects. This course provides students with a comprehensive understanding of project management principles, practices, and tools essential for managing engineering projects successfully. It covers key areas such as project selection and feasibility analysis, scope definition, scheduling techniques, cost and quality management, risk assessment, and performance monitoring using methods such as Earned Value Management. The course also addresses leadership, communication, and ethical considerations, enabling students to manage projects systematically in professional and industry-oriented environments.	**01**
01.	**Fundamentals of Project Management** **Contents:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI).	**4-6**
02.	**Project Selection, Initiation, and Feasibility Analysis** **Contents:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6-8
03.	**Project Planning and Scheduling Techniques** **Contents:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	**7-9**
04.	**Planning Project and Risk Management** **Contents:** Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan, Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks.	**6-8**
	Project Monitoring, Control, and Contracting	**6-8**

05.	**Contents:** Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit. Project Contracting, Project procurement management, contracting and outsourcing.	
06.	**Project Leadership, Closure and Documentation**	**4-6**
	Contents: Introduction to project leadership, ethics in projects, Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lesson learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
	Course Conclusion: Upon completion of the Project Management course, students will be able to systematically plan, manage, monitor, and close engineering projects using established project management principles and tools. They will demonstrate the ability to work effectively in teams, manage risks and stakeholders, make informed managerial decisions, and document lessons learned. The course prepares students to take on professional roles that require project coordination, leadership, and ethical responsibility in real-world engineering and organizational environments.	**01**
	Total	**45**

Course Outcomes: A learner will be able to-

1. Apply engineering fundamentals to interpret project management concepts, project life cycle phases, stakeholder roles, and organizational structures required for systematic project execution.
2. Analyze and evaluate project proposals using structured selection and feasibility techniques, identify tasks and resources for project initiation, assess economic viability, and apply engineering principles to understand team development and dynamics.
3. Design and develop comprehensive project plans using work breakdown structures, cost estimation, and scheduling techniques, apply modern project management tools to optimize time and resource utilization, and evaluate project plans based on economic and financial considerations.
4. Apply project planning, communication, and risk management techniques to allocate and optimize resources, manage schedule uncertainties, engage stakeholders effectively, and analyze project risks to select appropriate response strategies for successful project execution.
5. Analyze, Monitor and control project performance using planning and execution parameters, applying quantitative measurement and modern project management tools, managing stakeholder communication and team coordination, and identifying procurement and contracting activities to ensure effective project execution.
6. Apply, demonstrate, and document project leadership and communication skills to execute project closure activities, manage project termination processes, ensure customer acceptance,

and prepare formal closure reports and lessons learned for professional growth and knowledge management.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC8021.1	3	-	-	-	-	-	-	-	-	-	-
CEPEC8021.2	3	3	-	-	-	-	-	-	-	3	-
CEPEC8021.3	-	-	3	-	3	-	-	-	-	3	-
CEPEC8021.4	-	3	-	-	-	-	-	-	3	3	-
CEPEC8021.5	-	3	-	-	3	-	-	-	-	3	-
CEPEC8021.6	3	-	-	-	-	-	-	-	3	-	3
Average	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**3**

Text Books:

1. Project Management: A Managerial Approach, Meredith, J. R. and Mantel, S. J. Jr., 2017, Wiley India, ISBN: 978-1-119-36911-7, 9th Edition.
2. Project Management: Planning, Scheduling, and Controlling, Chitkara, K. K., 2014, Tata McGraw-Hill Education, ISBN: 978-0-070-67713-9, 2nd Edition.
3. Project Management: The Managerial Process, Gray, C. F. and Larson, E. W., 2018, McGraw-Hill Education, ISBN: 978-1-259-66271-6, 7th Edition.
4. Project Management, Gopalan, M. R., 2014, Wiley India Pvt. Ltd., ISBN: 978-8126550807, 2nd Indian Edition.

Reference Books:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute, 2017, PMI Publications, ISBN: 978-1-62825-664-2, 6th Edition.
2. Successful Project Management, Gido, J. and Clements, J. P., 2018, Cengage Learning, ISBN: 978-1-337-10067-2, 6th Edition.
3. Project Management, Lock, D., 2014, Gower Publishing, ISBN: 978-1-409-46228-6, 10th Edition.

Other Resources:

1. NPTEL Course: Project Management by Prof. K. K. Aggarwal / Prof. S. C. Dutta, IIT Delhi Web Link – https://onlinecourses.nptel.ac.in
2. Project Management Institute (PMI), PMBOK® and Standards Repository, Online Resource Web Link – https://www.pmi.org
3. MIT OpenCourseWare, Project Management and Systems Engineering, Massachusetts Institute of Technology. Web Link – https://ocw.mit.edu
4. Coursera, Project Management Principles and Practices, University of California, Irvine Web Link – https://www.coursera.org

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

1. Assignment on live problems/case studies: 10 Marks
   (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.)
2. Technical Report Writing: 05 Marks
3. 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
OEC	OEC8022	Finance Management	03

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

Program Outcomes addressed:

1. PO1 : Engineering Knowledge
2. PO2 : Problem Analysis
3. PO10: Project Management & Finance

Course Objectives :

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Overview of Indian Financial System**	**5-7**
	Contents: Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
02.	**Concepts of Returns and Risks**	**6-8**
	Contents: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuit y Due; Continuous Compounding and Continuous Discounting	
03.	**Overview of Corporate Finance**	**9-11**
	Contents: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	

	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04.	**Capital Budgeting** **Contents:** Meaning and Importance of Capital Budgeting; Inputs forCapital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's10 Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10-12**
05.	**Sources of Finance** **Contents:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**5-7**
06.	**Dividend Policy** **Contents:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani- Miller Approach	**2-4**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8022.1	3	3	-	-	-	-	-	-	-	-	-
OEC8022.2	3	3	-	-	-	-	-	-	-	3	-
Average	**3**	**3**	-	-	-	-	-	-	-	**3**	-

References :

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC8023	Entrepreneurship Development and Management	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

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO6: The Engineer & The world
3. PO8: Individual and team work
4. PO9: Communication
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the fundamental concepts of entrepreneurship and effective management of business enterprises.
2. To develop understanding of business planning, ownership structures, and legal aspects related to entrepreneurship.
3. To familiarize students with the Indian entrepreneurial environment, including MSMEs, government policies, and support institutions.
4. To encourage entrepreneurial thinking by highlighting innovation, sustainability, and problem-solving in small and medium enterprises.

Module	Detailed Contents	Hrs
	Course Introduction This course is designed to develop a clear understanding of entrepreneurship as a career option and as a driver of economic growth. It covers the fundamentals of starting, organizing, and managing new ventures with special reference to the Indian business environment. The course explains business planning, legal frameworks, financial management, and government support for entrepreneurs. Emphasis is given to MSMEs, innovation, and sustainable development. Through practical insights and case discussions, the course prepares learners to identify opportunities and manage entrepreneurial challenges effectively.	**01**
01.	**Overview of Entrepreneurship**	**05-07**
	Content: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	

02.	**Business Plans and Importance of Capital to Entrepreneurship**.	**06-08**
	Contents: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur. Entrepreneurship and Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	
03.	**Women and Social Entrepreneurship**	**08-10**
	Contents: Concept and evolution of women entrepreneurship in India. Role and importance of women entrepreneurs in economic and social development. Characteristics, strengths, and challenges faced by women entrepreneurs. Government policies, schemes, and institutional support for women entrepreneurship. Role of self-help groups (SHGs), NGOs, and microfinance institutions in promoting women-led enterprises. Case studies of successful women entrepreneurs. Concept, meaning, and scope of social entrepreneurship. Difference between social entrepreneurship and traditional entrepreneurship. Role of social entrepreneurs in addressing social, economic, and environmental issues. Models of social enterprises and sources of funding.	
04.	**Indian Environment for Entrepreneurship**	**07-09**
	Contents: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organizations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	
05.	**Effective Management of Business**	**04-06**
	Contents: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
06.	**Achieving Success In The Small Business**.	**04-06**
	Contents: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand entrepreneurship fundamentals and collaboratively present a basic business plan

using effective teamwork, analysis, and communication skills.

2. Interpret business planning, financing, legal, and operational aspects of entrepreneurship, demonstrating the ability to develop, evaluate, and present comprehensive business strategies.
3. Understand the principles of women and social entrepreneurship and associated support systems.
4. Comprehend MSME regulations, financial schemes, and government support systems, and present structured reports for informed decision-making.
5. Identify challenges faced by micro and small enterprises and develop practical solutions, collaboratively presenting integrated case studies and informed management decisions.
6. Understand the small business life cycle and growth strategies, and collaboratively present solutions to real world business challenges.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8023.1	2	-	-	-	-	-	-	3	3	-	-
OEC8023.2	2	-	-	-	-	-	-	-	3	3	-
OEC8023.3	2	-	-	-	-	3	-	3	-	-	3
OEC8023.4	2	-	-	-	-	3	-	-	3	-	-
OEC8023.5	2	-	-	-	-	-	-	3	3	-	-
OEC8023.6	2	-	-	-	-	-	-	3	3	-	-
Average	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**3**	**3**	**3**

Text Books :

1. Poornima Charantimath, Entrepreneurship Development – Small Business Enterprise, Pearson Education.
2. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education.
3. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House.

Reference Books :

1. T. N. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi.
2. Madhurima Lall & Shikha Sahai, Entrepreneurship, Excel Books.
3. C. N. Prasad, Small and Medium Enterprises in Global Perspective, New Century Publications, New Delhi,

Other Resources :

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8024	Human Resource Management	03

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

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Collaborative Teamwork
3. PO10: Project Management and Finance

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction to HR**	**4-6**
	Contents: - Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions - Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	
02.	**Organizational Behaviour (OB)**	**7-9**
	Contents: - Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues - Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness - Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior - Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);	

	- Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. - Case study	
03.	**Organizational Structure &Design** **Contents:** - Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. - Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. - Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**6-8**
04.	**Human resource Planning** **Contents:** - Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale - Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning - Training & Development: Identification of Training Needs, Training Methods	**5-7**
05.	**Emerging Trends in HR** **Contents:** - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	**6-8**
06.	**HR -MIS, Strategic HRM and Labor Laws & Industrial Relations** **Contents:** - Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries - Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals - Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**9-11**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

1. Understand the concepts, aspects, techniques and practices of the human resource management
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8024.1	-	-	-	-	-	-	3	3	-	3	-
OEC8024.2	-	-	-	-	-	-	3	3	-	3	-
OEC8024.3	-	-	-	-	-	-	3	3	-	3	-
OEC8024.4	-	-	-	-	-	-	3	3	-	-	-
Average	-	-	-	-	-	-	**3**	**3**	**-**	**3**	**-**

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC8025	Professional Ethics & Csr	03

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

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Professional Ethics and Business**	**3-5**
	Contents: The Nature of Business Ethics; Ethical, Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
02.	**Professional Ethics in the Marketplace, Professional Ethics and the Environment**	**8-10**
	Contents: - Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy - Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
03.	**Professional Ethics of Consumer Protection, Professional Ethics of Job Discrimination**	**6-8**
	Contents: - Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy - Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
04.	**Introduction to Corporate Social Responsibility**	**5-7**
	Contents: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	

05.	**Corporate Social Responsibility**	**8-10**
	Contents: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06.	**Corporate Social Responsibility in Globalizing India**	**7-9**
	Contents: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8025.1	-	-	-	-	-	3	3	-	-	3	-
OEC8025.2	-	-	-	-	-	3	3	-	-	3	-
OEC8025.3	-	-	-	-	-	3	3	-	-	-	-
OEC8025.4	-	-	-	-	-	3	3	-	-	3	-
Average	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC8026	Circular Economy	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

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: Lifelong Learning

Course Objectives:

1. To introduce the fundamentals and need for Circular Economy (CE)
2. To impart the knowledge about environmental and economic impacts of products.
3. To make learner understand circular materials and product strategies.
4. To impart the knowledge of CE business models in engineering industries.

Module	Detailed Contents	Hrs
	Course Introduction This course introduces the Circular Economy (CE) paradigm—a transformative approach that shifts from linear consumption to restorative and regenerative systems. By embracing CE principles, engineers can contribute to designing products, processes, and infrastructures that maximize resource efficiency, reduce waste, and promote economic, environmental, and social sustainability.	**01**
01.	**Introduction to Circular Economy**	**05-07**
	Content: Linear economy, Role of the Industrial revolution in Linear economy, Disadvantages of Linear economy, Replacing Linear by Circular economy, History and evolution of circular economy, Global CE initiatives (EU Circular Economy Action Plan, UN SDGs), Role of R's in circular economy, Value optimization, Design out waste, Renewable energy, A differential- Linear vs. Circular economy, Building a resilient economy, Role of engineers in CE	
02.	**Systems Thinking and Life Cycle Thinking**	**06-08**
	Contents: Systems Thinking in CE, Core principles of Systems Thinking in CE, Application in the Circular Economy	

	Concept of Loops, Circularity, Life Cycle Analysis(LCA), Importance of LCA, An efficient approach by Neptune Pumps, Case study-winnow solutions, Embodied energy and material flows, Input-output analysis in industrial systems	
03.	**Circular Design and Materials Engineering**	**07-09**
	Contents: Material recovery, waste reduction, Reducing negative externalities, Connecting Businesses and people for circularity, Butterfly diagram, Design for disassembly, modularity, repairability, Materials selection for durability and recyclability , Bio-based and regenerative materials, Eco-design principle	
04.	**Circular Business Models and Industrial Applications**	**07-09**
	Contents: Circular Business Models, Product-as-a-Service (PaaS), Reverse logistics, remanufacturing, and refurbishment, Industrial symbiosis and closed-loop systems, Digital technologies enabling CE (IoT, blockchain, AI)	
05.	**Waste Management and Resource Recovery**	**06-08**
	Contents: Circular waste hierarchy, Urban mining and e-waste recycling, Industrial and agricultural waste valorization, Waste-to-energy and bioconversion technologies	
06.	**Circular Economy Implementation and Policy**	**06-08**
	Contents: CE indicators and metrics (e.g., Circularity Gap Report), National and international CE policies, Corporate sustainability and ESG frameworks, Roadmaps and barriers to implementation	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learner will be able to

1. Analyze the need for Circular Economy (CE) and apply systems and life cycle thinking to engineering
2. Integrate CE in design and material selection
3. Analyse real-world industrial circular practices
4. Apply engineering approaches to waste minimization and resource recovery
5. Analyse policy, regulations, and corporate strategies and integrate CE into engineering practice

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8026.1	3	3	-	-	-	3	3	-	-	3	3
OEC8026.2	3	3	3	-	-	3	-	-	-	3	-
OEC8026.3	3	3	-	-	-	3	3	-	-	-	3

OEC8026.4	3	3	-	-	-	3	3	-	-	-	3
OEC8026.5	3	3	3	-	-	3	3	-	-	-	3
Average	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**3**

Text Books :

1. Circular Economy: Principles and Benefits, Ken Webster., First Edition 2017, Ellen MacArthur Foundation Publishing.
2. Product Design and Life Cycle Assessment, Ireneusz Zbicinski, Danuta Romanowska, Barbara Bednarowska, First Edition, 2021, Springer
3. Designing for the Circular Economy, Martin Charter, Ursula Tischner, First Edition, 2017 Routledge

Reference Books :

1. The Circular Economy: A User's Guide, Subramanian Senthilkannan Muthu, First Edition, 2020, Springer
2. Industrial Ecology and Circular Economy: Energy and Resource Efficiency in Industry, Yasemin Gursoy, Bilge Sener, First edition, 2021, Springer.
3. Cradle to Cradle: Remaking the Way We Make Things, William McDonough, Michael Braungart, First edition, 2002, North Point Press

Other Resources :

1. NPTEL Course: Sustainable Engineering Concepts and Life Cycle Analysis, Prof. Brajesh Kumar Dubey | IIT Kharagpur
   Web Link- https://onlinecourses.nptel.ac.in/noc24_ce61/preview
2. NPTEL Course: Linear to Circular Economy, Prof Shalini Goyal Bhalla, IIT Roorkee
   Web Link- https://onlinecourses.swayam2.ac.in/aic21_ge19/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
OEC	OEC8027	IPR and Patenting	03

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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO5: Engineering Tool Usage
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO8: Individual and Collaborative Team work
7. PO9: Communication
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce students to the significance of Intellectual Property and its impact on innovation and professional growth.
2. To clarify the essential concepts and distinctions among patents, copyrights, trademarks, industrial designs, trade secrets, and GI.
3. To simplify statutory provisions and legal procedures so students can confidently interpret various IPR frameworks.
4. To guide students in applying practical steps for obtaining, managing, and safeguarding different IP rights.
5. To foster ethical reasoning, holistic professional judgement, and awareness of cyber laws relevant to IPR

Module	Details	Hrs.
	Course Introduction The course introduces students to the fundamental concepts, legal frameworks, procedures, and applications of Intellectual Property Rights (IPR). With rapid technological advancement, understanding how to protect innovations is essential for engineers. This course equips learners with the knowledge to identify different forms of intellectual property, file and maintain IP rights, and manage IP assets ethically and strategically. Students will also develop awareness of cyber laws as they relate to digital content and IP.	**01**
01.	**Introduction to IPR**	**7-9**
	Contents:	

	Concept of Property, Tangible and Intangible Property, Intellectual Property: Definition, Need & Importance, Types of IPR: Patents, Copyright, Trademark, GI, Trade Secrets, Industrial Design, Evolution of IP laws: Paris Convention, Berne Convention, WIPO creation, TRIPS, Indian IPR system: CGPDTM, Copyright Office, GI Registry, PVPFR Authority, Role of IPR in R&D, Innovation, and International Trade.	
02.	**Patents**	**8-10**
	Contents: Patent definition, objectives, values and advantages, Criteria of patentability: Novelty, Inventive Step, Industrial Application, Non-patentable inventions under Indian law, Types of Specifications: Provisional, Complete, Parts of a Patent: Title, Field, Background, Description, Drawings, Claims, Abstract, Filing procedure: Forms (1, 2, 3, 5, 9, 18, 26), Examination, FER, Grant, Renewal, PCT Filing, Priority Date, Patent Cooperation Treaty, Revocation, Opposition: Pre-Grant & Post-Grant, Prior art search: Keywords, Boolean operators, Databases (WIPO, USPTO, Google Patents)	
03.	**Trademarks, Industrial Designs and GI**	**8-10**
	Contents: Trademarks: Definition, Functions, Brand Value, Distinctiveness, Types of marks (word, device, shape, color), Registration process, challenges in non-conventional marks, Infringement, Passing off, Domain name disputes, well-known marks. Industrial Designs: Definition, Novelty, Originality, Registration process, Infringement and remedies. Geographical Indications (GI): Meaning & Importance, Registration of GI goods, Indian GI examples.	
04.	**Copyright, Trade Secrets & Emerging IP**	**7-9**
	Contents: Copyright: Meaning, Subject Matter, Economic and Moral Rights, Ownership, Transfer, Licensing, Fair dealing, infringement, remedies, Copyright in the digital era. Trade Secrets: Conditions for protection, Misappropriation, NDAs, employment contracts. Emerging IPR: Plant varieties, Integrated circuit layout designs, Undisclosed information, Digital content issues (streaming, snippet tax)	
05.	**Cyber Laws for Digital IP Protection**	**4-6**
	Contents: Cyber Laws: IT Act 2000**,** Cybercrimes: identity theft, phishing, e-commerce fraud**,** Digital signatures, data protection, privacy**,** International cyber law issues.	

06.	**IP Management, Documentation and Commercialization**.	**3-5**
	Contents: Managing IP: IP documentation, Letters of instruction, Joint collaboration agreements, NDA, Cease & Desist, Settlement memorandum, Assignment & Licensing, Technology Transfer (ToT), IP valuation basics.	
	Course Conclusion	**01**
	The course provides a comprehensive understanding of Intellectual Property Rights and their relevance in engineering, innovation, and global business. Learners gain practical insights into patent drafting, trademark and design registration, copyright compliance, and cyber law frameworks. By the end of the course, students are equipped with knowledge and skills necessary to create, protect, and manage intellectual assets responsibly.	
	Total	**45**

Course Outcomes: Learner will be able to -

1. Compare fundamental IPR concepts by classifying major IP types and outlining key elements of India's IPR policy.
2. Identify key elements of patent fundamentals by outlining patentability criteria, filing steps and prior-art search procedures.
3. Identify essential aspects of trademarks, industrial designs and GI by interpreting legal and registration documentation.
4. Apply copyright, trade-secret and emerging IP provisions by identifying protected subject matter and reviewing case documentation.
5. Analyze cyber laws for digital IP protection by examining cybercrimes, preparing structured reports and evaluating credible cybersecurity and data-privacy information.
6. Evaluate IP management practices by assessing key documentation and critically examining clauses in licensing and collaboration agreements.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8027.1	--	3	--	--	--	3	3	--	--	--	--
OEC8027.2	--	3	--	--	2	3	3	--	--	--	--
OEC8027.3	--	3	--	--	2	3	--	3	3	3	--
OEC8027.4	3	3	--	--	--	3	--	--	--	--	--
OEC8027.5	3	--	--	--	--	3	--	--	--	--	--
OEC8027.6	--	3	--	--	--	3	--	--	--	--	--
Average	**3**	**3**	**--**	**--**	**2**	**3**	**3**	**3**	**3**	**3**	**--**

Text Books :

1. D. E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents & Trade Secrets, Cengage Learning, 2012.
2. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, 2nd ed., McGraw-Hill Education, 2010.
3. P. Narayanan, Intellectual Property Law, 3rd ed., Eastern Law House, 2010.

Reference Books :

1. F. Ali, The Law of Patents, LexisNexis, 2017.
2. R. Stim, Patent, Copyright & Trademark, 17th ed., NOLO Press, 2019.
3. WIPO, WIPO Intellectual Property Handbook, World Intellectual Property Organization, 2020.
4. K. C. Kailasam and R. Vedaraman, Law of Trademarks and Passing Off, LexisNexis, 2013.

Other Resources :

1. NPTEL Course: Intellectual Property Rights and Competition Law
   Web link- https://onlinecourses.nptel.ac.in/noc25_mg132/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8028	Disaster Management and Mitigation Measures	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

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Modern Tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO8: Individual and Collaborative Team Work
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce fundamental concepts of disasters and relevance of disaster studies in engineering practice.
2. To convey causes and impacts of natural, human-induced, and emerging disasters
3. To familiarize students with disaster management frameworks and governance by studying national institutions, policies and international disaster risk reduction frameworks
4. To introduce modern technologies, geospatial tools, and data-driven approaches used in disaster management for risk reduction.
5. To teach concepts of disaster response, financing, and recovery mechanisms by analysing relief operations, logistics, medical response, risk financing, and Build Back Better principles.
6. To guide students about mitigation, preparedness, and community resilience by emphasizing structural and non-structural mitigation and ethical responsibility of engineers.

Module	Details	Hrs
	Course Introduction Disaster Management and Mitigation Measures is an interdisciplinary course that equips engineering students with essential knowledge to understand, assess, and reduce the impacts of natural and human-induced disasters. The course introduces fundamental disaster concepts, global and Indian disaster trends, and the growing influence of climate change and extreme events on society and infrastructure. Emphasis is placed on the role of engineers in disaster risk reduction through safe design, planning, technology adoption, and resilient	**01**

	infrastructure development. Students gain insights into disaster preparedness, response, mitigation strategies, and emerging risks, enabling them to contribute effectively to sustainable development, community safety, and national resilience in an increasingly hazard-prone world.	
01.	**Foundations of Disaster Risk Science**	**06-08**
	Contents: Disaster Concepts & Impacts: Direct, indirect and cascading effects, Social, economic & environmental consequences, Disaster-induced development challenges. Risk & Hazard Assessment: Components of disaster risk, Hazard identification & vulnerability assessment, Multi-hazard environment. Climate Change & Emerging Risks: Heatwaves, drought intensification, extreme rainfall, Sea-level rise & coastal vulnerability, Urban heat islands. Indian Context, India's hazard zonation: seismic, cyclone, landslides, flood, drought, Disaster statistics & case studies	
02.	**Natural & Human-Induced Disasters**	**05-07**
	Contents: Natural Disasters: Geological: Earthquakes, Tsunamis, Volcanoes, Landslides, Hydro-meteorological: Flood, Flash Flood, Drought, Cyclones, Cloudburst, Climate-related: Heatwaves, extreme weather events. Human-Induced & Technological Disasters: Industrial accidents, Chemical disasters (Bhopal), Nuclear hazards (Fukushima), Fire hazards (urban & industrial) Transportation accidents (rail/road/air/maritime), Infrastructure failures (dams, bridges, tunnels), Cyber-disasters & critical infrastructure cyber threats.	
03.	**Disaster Management Frameworks, Policy & Governance**	**07-09**
	Contents: Disaster Management Principles: Disaster management cycle, prevention, preparedness, response, recovery. Indian Disaster Governance: NDMA, SDMA, DDMA, NIDM roles and frameworks, National & state policies. International Frameworks & Standards: Sendai Framework for Disaster Risk Reduction, UNDRR, Sphere Standards, Global Humanitarian Principles, ESG & resilience reporting.	
04.	**Technology, Tools & Geospatial Intelligence**	**07-09**
	Contents:	
	GIS, Remote Sensing & GPS Applications: Demand Assigned Access Hazard mapping, Flood/landslide susceptibility mapping, Satellite-based early warning Modern Technologies: Drones & UAVs for reconnaissance, Web GIS platforms AI/ML & Data Analytics: ML models for rainfall, cyclone, flood prediction, Computer vision for damage assessment Smart Disaster Technologies: IoT-based early warning systems, Digital twins for urban planning, Smartphone apps (GEM, IMD, NDMA tools.	
05.	**Financing, Response, Relief & Rehabilitation**	**06-08**

	Contents: Disaster Financing Mechanisms: Risk financing & risk transfer, Insurance models (crop, property, catastrophe bonds), Pradhan Mantri Fasal Bima Yojana & other Indian schemes. Response & Relief Operations: Search & Rescue by NDRF, SDRF, NGOs, armed forces, Logistics management & supply chain resilience, Medical triage & emergency health systems. Recovery, Rehabilitation & Build Back Better: Post-disaster needs assessment (PDNA), Reconstruction policies, Resilient infrastructure design, Community resilience & social inclusion.	
06.	**Preventive, Mitigation & Community-Based Approaches**	**06-08**
	Contents: Structural Mitigation: Seismic design, retrofitting, Cyclone shelters & bio-shields, Flood protection structures, Storm-water management. Non-Structural Mitigation: Policy intervention & awareness, Capacity building, Early warning & communication systems, Land-use planning/zoning. Community Based Disaster Risk Reduction: Role of community institutions, NGOs & volunteers, Risk communication models, Indigenous knowledge systems	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learners will be able to

1. Summarize disaster concepts and analyse impacts and risk components in multi-hazard environments.
2. Classify and evaluate natural, human-induced, and technological disasters with reference to Indian and global case studies.
3. Interpret disaster management policies, governance frameworks, and institutional roles at national and international levels.
4. Apply modern tools and technologies such as GIS, remote sensing, and data analytics for disaster risk reduction.
5. Formulate/Design mitigation, preparedness, and recovery strategies incorporating community participation, sustainability, and resilience principles.

CO-PO Mapping Table with Correlation Level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8028.1	3	3	-	-	-	-	-	-	-	-	-
OEC8028.2	3	-	-	-	-	3	-	-	-	-	-
OEC8028.3	-	3	-	-	-	-	3	-	-	-	-
OEC8028.4	-	-	-	-	3	3	-	-	-	-	-
OEC8028.5	-	-	3	-	-	3	3	-	-	-	-
Average	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**-**

Text Books:

1. D. P. Coppola, *Introduction to International Disaster Management*, 3rd ed. Oxford, U.K.: Butterworth-Heinemann (Elsevier), 2015.
2. R. Shaw, S. Srinivas, and A. Sharma, *Disaster Risk Reduction: Methods, Approaches and Practices*, Singapore: Springer, 2014.
3. P. Sammonds, T. Glade, and M. Bubeck, *Disaster Management and Mitigation: Early Warning Systems, Community Resilience and Sustainability*, London, U.K.: Springer, 2016.
4. D. Alexander, *Natural Disasters*, 2nd ed. Dordrecht, The Netherlands: Springer, 2000.
5. A. S. Arya, *Disaster Management: Institutions and Policies*, New Delhi, India: Gyan Publishing House, 2006.

Reference Books:

1. A. K. Jha, R. Duyne Barenstein, P. M. Phelps, D. Pittet, and S. Sena, Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters, Washington, DC, USA: World Bank, 2010.
2. United Nations Office for Disaster Risk Reduction (UNDRR), Sendai Framework for Disaster Risk Reduction 2015–2030, Geneva, Switzerland: United Nations, 2015.
3. D. Alexander, Principles of Emergency Planning and Management, Oxford, U.K.: Oxford University Press, 2002.
4. National Disaster Management Authority (NDMA), Government of India, National Disaster Management Plan, New Delhi, India, Latest Edition.
5. C. Emdad Haque and M. Q. Zaman, Disaster Risk Reduction: Methods, Approaches and Practices, New York, NY, USA: Springer, 2014.

Other Resources :

1. NPTEL: Satellite communication, Prof. Kalyan Kumar Bandyopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/117105131
2. NPTEL/SWAYAM: Climate Change — Science, Impacts & Extreme Events https://onlinecourses.nptel.ac.in/noc25_ce135/preview
3. UDEMY: Advances in Disaster Management: Principles and Practices https://www.udemy.com/share/10aBGu/
4. ISRO IIRS E-Learning: Geospatial Technology for Disaster Risk Reduction (GIS, RS & GPS) https://elearning.iirs.gov.in/courses/paper_05/default.htm
5. **NDMA, Government of India – Policies, Guidelines & SOPs** https://ndma.gov.in/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)

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

B. END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
OEC	OEC8029	Environmental Management	03

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

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Module	Details	Hrs.
	Course Introduction	**01**
01.	**Introduction and Definition of Environment**	**9-11**
	Contents: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
02.	**Global Environmental concerns**	**6-8**
	Contents: Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
03.	**Concepts of Ecology**	**5-7**
	Contents: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
04.	**Environmental Management and Government Regulation**	**10-12**
	Contents: Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
05.	**Quality-Based Environmental Management and ISO 14000 Framework**	**5-7**
	Contents:	

	Total Quality Environmental Management, ISO-14000, EMS certification.	
06.	**Overview of Environmental and Industrial Legislations**	**2-4**
	Contents: General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8029.1	-	-	-	-	-	3	3	-	-	3	-
OEC8029.2	-	-	-	-	-	3	3	-	-	-	-
OEC8029.3	-	-	-	-	-	3	3	-	-	3	-
Average	-	-	-	-	-	**3**	**3**	-	-	**3**	-

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers
   London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance
   For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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
MJP	MJP802	Major Project-B	04

A. Guidelines for the Major Project-B

1. Project Continuation

- The project initiated in Semester VII (Major Project – A) continues in Semester VIII.
- Project Objectives, Outcomes, and POs remain the same.

2. Focus for Semester VIII

- This phase emphasizes completion, optimization, testing, performance evaluation, and deployment (where applicable).
- Students should work toward:
  - Validation through experiments, benchmarking, or user trials
  - Technical documentation and dissemination (paper, poster, demonstration)

3. Research and Innovation Encouragement

- Teams are encouraged to:
  - Present papers in conferences/symposia/workshops
  - Participate in inter-college / national project competitions or hackathons
  - Submit project outcomes to innovation cells, incubation centres, etc.
- Such activities carry marks under In-Semester Continuous Assessment (CIA).

4. Project Execution and Supervision

- The guide continues to monitor weekly progress and maintain:
  - Work logs
  - Attendance
  - Contribution records
- The department's **Project Progress Monitoring Committee** shall evaluate **at least two** progress reviews during the semester**.**

5. Project Report (Final Submission)

The final project report must include:

- Revised/Final Abstract
- Literature Review (updated if needed)
- Final System Design, Implementation, and Architecture
- Experimental Setup and Evaluation Parameters
- Results with Comparative Analysis
- Discussion, Conclusion & Limitations
- Future Scope and Applications
- References (IEEE format preferred)
- Appendices (Certificates, Publications, Competition Participation**, etc.)**

B. In-Semester Continuous Assessment (CIA) — *Total: 50 Marks*

Component	Description	Marks
Progress Review Presentation I	Demonstration of implementation progress with clarity in design and execution	10
Progress Review Presentation II	Demonstration of testing, validation, and refinement; readiness for final deployment	10
Research / Innovation Activities	• Participation/winning in project competitions, hackathons, etc. • Technical paper writing/presentation/publication	05 10
Final Draft Report (Spiral/Soft Copy)	Quality of documentation, structure, clarity, proper referencing, and reflection of actual work	10
Regularity & Active Participation	Consistent attendance, timely submissions, teamwork, individual responsibility, and weekly log progress	05

C. End Semester Examination (ESE) — *Total: 50 Marks*

Examination by Internal + External Examiners

Component	Description	Marks
Project Demonstration / Prototype Performance	Functional correctness, performance, robustness, completeness of implementation	20
Oral Presentation and Defence	Clarity in explaining methodology, decisions, results, and the ability to answer technical questions	15
Project Report (Final Hard-Bound Submission)	Technical depth, coherence, experimental analysis quality, formatting standards, and completeness	10
Individual Contribution Assessment	Clear evidence of individual technical contribution and responsibility within the team	05