CURRICULUM
&
SYLLABUS
2023 Scheme
(Autonomous)
Version 1.0

B.TECH
ELECTRICAL AND COMPUTER ENGINEERING

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Mar Ivanios Vidyanagar, Nalanchira, Thiruvananthapuram – 695015

CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

SEMESTERS VII & VIII

2023 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

FOURTH YEAR SYLLABUS

2023 SCHEME

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	25/02/2026	12/03/2026

Head of Department
Chairman, Board of Studies

MAR BASELIOS COLLEGE OF ENGINEERING & TECHNOLOGY
(Autonomous)
Mar Ivanios Vidyanagar
Nalanchira
Thiruvananthapuram-695015

Principal
Chairman, Academic Council

Principal
Mar Baselios College
of Engineering & Technology
Mar Ivanios Vidyanagar, Nalanchira
Thiruvananthapuram-695015

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE INSTITUTION

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

VISION AND MISSION OF THE DEPARTMENT

Vision:

To be a Centre of Excellence in Electrical & Electronics Engineering Education, Research and Application of knowledge to benefit the society at large.

Mission:

To mould quality Electrical Engineers, fostering creativity and innovation to address global issues.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Engineering Graduates will have the ability:

PEO1: Graduates will succeed as Engineering Professionals in Industry or as Entrepreneurs in Electrical and Computer Engineering and the related disciplines and exhibit an urge for innovation.

PEO2: Graduates will be able to adapt to the advances in Technology by acquiring knowledge and skills manifested through continuous learning and higher qualifications.

PEO3: Graduates will be serving community as socially committed individuals, exhibiting professional ethics in addressing the technical and engineering challenges.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Engineering Graduates will have the ability:

PSO1: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development testing and operation of Power and Energy Systems in the areas of Generation, Transmission, Conversion, Distribution and Utilization systems.

PSO2: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development and operation of Industrial systems in the areas of Automation, Control, Energy Management and Economic operation.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.TECH. PROGRAMME IN ELECTRICAL AND COMPUTER ENGINEERING

For the students admitted from 2023-24

SCHEDULING OF COURSES

i) Knowledge Segments and Credits

Every course of BTech Programme is placed in one of the nine categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Proposed 2023 Curriculum
1	Humanities and Social Sciences including Management Courses	HSC	9
2	Basic Science Courses	BSC	26
3	Engineering Science Courses	ESC	24
4	Programme Core Courses,	PCC	69
5	Programme Elective Courses	PEC	18
6	Institute Elective Courses	IEC	6
7	Seminar, Mini Project, Project Work, Internship and Comprehensive Course Viva Voce	PWS	15
8	Mandatory Student Activities (P/F)	MSA	3
Total Mandatory Credits			**170**
	Value Added Courses (Optional) – Honours/Minor	VAC	15

ii) Semester-wise Credit Distribution

Semester	***I***	***II***	***III***	***IV***	***V***	***VI***	***VII***	***VIII***	***Total***
Credits for Courses	***19***	***21***	***23***	***21***	***21***	***22***	***23***	***17***	***167***
Year wise Credit	***40***		***44***		***43***		***40***		***167***
Credits for Activities	***3***								***3***
Total Credits									***170***
Value Added Courses (Optional) – Honours / Minor									***15***
Total Credits									***185***

Humanities and Social Sciences including Management Courses: Universal Human Values, Management for Engineers, Business Economics and Accountancy.
Basic Science Courses: Mathematics, Engineering Physics, Engineering Chemistry, Engineering Physics and Chemistry Labs.
Engineering Science Courses: Basics of Electrical and Electronics Engineering, Engineering Mechanics, Engineering Graphics, Design Engineering, Programming in Python, Problem Solving and programming in C, Manufacturing and Construction Practices B, Electrical and Electronics Workshop.
Mandatory Non-credit Courses: Environmental Science, Professional Communication, Professional Ethics, Industrial Safety Engineering.

v) General Guidelines

Four hours are kept exclusively for the Remedial / Minor/ Honours courses from third to seventh semester. For the mini project of Minor or Honours in S7/S8, 7 hours are allotted. If a student does not opt for Minor/Honours courses, he/she can be given remedial classes.

SEMESTER I										
Slot	Cate-gory	Course Code	Courses	Credit Structure				SS	Hours	Credit
				L	T	P	J			
A	BSC	23MAL10A	Linear Algebra and Calculus	3	1	0	0	5	4	4
B	BSC	23CYL10A	Engineering Chemistry	3	1	0	0	5	4	4
C	ESC	23ESB10A	Engineering Graphics	2	0	2	0	4	4	3
D	ESC	23ESB10D	Problem Solving and Programming in C	2	1	2	0	4.5	5	4
G	ESC	23ESL1NA	Environmental Science	2	0	0	0	3	2	1*
S	BSC	23CYP10A	Engineering Chemistry Lab	0	0	2	0	1	2	1
T	ESC	23ESB10P	Manufacturing and Construction Practices B	1	0	2	0	2.5	3	2
TOTAL								**25**	**24**	**19**

**Not to be considered for Grade/GPA/CGPA. Pass or Fail Only*

SEMESTER II										
Slot	Cate-gory	Course Code	Courses	Credit Structure				SS	Hours	Credit
				L	T	P	J			
A	BSC	23MAL10B	Vector Calculus, Differential Equations and Transforms	3	1	0	0	5	4	4
B	BSC	23PYL10A	Engineering Physics	3	1	0	0	5	4	4
C	ESC	23ESL10C	Engineering Mechanics	2	1	0	0	3.5	3	3
D	ESC	23ESB10G	Python Programming	2	0	2	0	4	4	3
E	ESC	23ESL10J	Basics of Electrical Engineering-A	2	0	0	0	3	4	2
		23ESL10L	Basics of Electronics Engineering	2	0	0	0			2
G	HSC	23HSJ1NB	Professional Communication	2	0	0	2	5	4	1*
S	BSC	23PYP10A	Engineering Physics Lab	0	0	2	0	1	2	1
T	ESC	23ESP10B	Electrical and Electronics Workshop	0	0	2	0	1	2	1
TOTAL								**27.5**	**27**	**21**

**Not to be considered for Grade/GPA/CGPA. Pass or Fail Only*

SEMESTER III										
Slot	**Category**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	BSC	23MAL20B	Discrete Mathematical Structures	3	1	0	0	5	4	4
B	PCC	23ELL20A	Instrumentation Systems	3	1	0	0	5	4	4
C	PCC	23ELL20B	Data Structures	3	1	0	0	5	4	4
D	PCC	23EEL20C	Electric Circuit Analysis	3	1	0	0	5	4	4
E	ESC	23ESL00A	Design Engineering	2	0	0	0	3	2	2
G	HSC	23HSL2NA	Professional Ethics	2	0	0	0	3	2	1*
S	PCC	23ELP20A	Data Structures Lab	0	0	3	0	1.5	3	2
T	PCC	23ELP20B	Instrumentation Lab	0	0	3	0	1.5	3	2
M	VAC		Minor Course	3	0	0	0	4.5	3	3
TOTAL								**29/ 33.5**	**26/29**	**23/26**

**Not to be considered for Grade/GPA/CGPA. Pass or Fail Only*

SEMESTER IV										
Slot	**Category**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	BSC	23MAL20D	Probability, Statistics and Numerical Methods	3	1	0	0	5	4	4
B	PCC	23ELL20D	Computer Organization and Architecture	3	1	0	0	5	4	4
C	PCC	23ELB20E	Object Oriented Programming Using JAVA	3	0	3	0	6	6	5
D	PCC	23ELL20F	Digital Electronics and Logic Design	3	1	0	0	5	4	4
E	HSC	23HSL2NB	Universal Human Values - II	2	1	0	0	3.5	3	1*
G	ESC	23ESL2NC	Industrial Safety Engineering	2	1	0	0	3.5	3	1*
S	PCC	23ELP20C	Digital Electronics and Logic Design Lab	0	0	3	0	1.5	3	2
M/H	VAC		Minor/Honours Course	3	0	0	0	4.5	3	3
				2	1	0	0	3.5		
TOTAL								**29.5/ 34/33**	**27/30**	**21/24**

**Not to be considered for Grade/GPA/CGPA. Pass or Fail Only*

SEMESTER V										
Slot	**Cate-gory**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	PCC	23ELL30A	Database Management Systems	3	1	0	0	5	4	4
B	PCC	23ELB30B	Microprocessors and Embedded Systems	3	1	2	0	6	6	5
C	PCC	23ELL30C	Electrical Machines	3	1	0	0	5	4	4
D	HSC	23HSL30A	Business Economics and Accountancy	3	0	0	0	4.5	3	3
E	PEC	23ELL31X	Program Elective I	3	0	0	0	4.5	3	3
S	PCC	23ELP30A	Electrical Machines Lab	0	0	2	0	1	2	1
T	PCC	23ELP30B	Database Management System Lab	0	0	2	0	1	2	1
M/H	VAC		Minor/Honours Course	3	0	0	0	4.5	3	3
TOTAL								**27/ 31.5**	**24/27**	**21/24**

SEMESTER VI										
Slot	**Cate-gory**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	PCC	23ELL30D	Power Electronics	3	1	0	0	5	4	4
B	PCC	23ELL30E	Algorithm Analysis and Design	3	1	0	0	5	4	4
C	PCC	23ELL30F	Computer Communication and Network Security	3	0	0	0	4.5	3	3
D	PEC	23ELL32X	Program Elective II	3	0	0	0	4.5	3	3
E	IEC	23IEL31X	Institute Elective I	3	0	0	0	4.5	3	3
S	PCC	23ELP30C	Networking Lab	0	0	2	0	1	2	1
T	PWS	23ELS38A	Seminar	0	0	4	0	2	4	2
U	PWS	23ELJ38B	Mini Project	0	0	4	0	4	4	2
M/H	VAC		Minor/Honours Course	3	0	0	0	4.5	3	3
				2	1	0	0	3.5		
TOTAL								**30.5/ 35/34**	**27/30**	**22/25**

SEMESTER VII										
Slot	**Cate-gory**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	PCC	23ELL40A	Control Systems	3	1	0	0	5	4	4
B	PCC	23ELL40B	Power System Engineering	3	1	0	0	5	4	4
C	PCC	23ELL40C	Internet of Things	3	0	0	0	4.5	3	3
D	PEC	23ELL43X	Program Elective III	3	0	0	0	4.5	3	3
E	IEC	23IEL42X	Institute Elective II	3	0	0	0	4.5	3	3
T	PWS	23ELV48A	Comprehensive viva voce	0	0	2	0	1	2	1
U	PWS	23ELJ48A	Project	0	0	10	0	10	10	5
		23ELI48A	Internship*							
M/H	VAC		Minor/Honours Course	0	0	6	0	6	5/3	3
				3	0	0	0	4.5		
TOTAL								**34.5/ 40.5/39**	**29/ 34/32**	**23/26**

**Students can opt for Internship either in S7 or S8. However, in S7, the internship can be permitted only if there are no pending Programme/Course requirements in the semester, that need to be completed in College in the offline mode, such as laboratory sessions.*

SEMESTER VIII										
Slot	**Cate-gory**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
A	PEC	23ELL44X	Program Elective IV	3	0	0	0	4.5	3	3
B	PEC	23ELL45X	Program Elective V	3	0	0	0	4.5	3	3
C	PEC	23ELL46X	Program Elective VI	3	0	0	0	4.5	3	3
D	HSC	23HSL00A	Management for Engineers	3	0	0	0	4.5	3	3
U	PWS	23ELJ48B	Project	0	0	10	0	10	10	5
		23ELI48A	Internship*							
M/H	VAC		Minor/Honours Course	0	0	6	0	6	5	3
TOTAL								**28/34**	**22/27**	**17/20**

**Students can opt for Internship either in S7 or S8.*

MICRO SPECIALIZATION STREAM		
No.	**STREAM**	**CODE**
1.	Power and Energy Systems	PES
2.	Control and Instrumentation	CAI
3.	Systems and Networks	SAN
4.	Artificial Intelligence and Machine Learning	AML

PROGRAMME ELECTIVE I

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
E	PEC	23ELL31A	Renewable Energy Conversions	3-0-0-0	3	3	PES
		23ELL31B	Electromagnetic Theory and Compatibility	3-0-0-0	3	3	PES
		23ELL31C	Signals and Systems	2-1-0-0	3	3	CAI
		23ELL31D	Biomedical Instrumentation	3-0-0-0	3	3	CAI
		23ELL31E	Introduction to Security in Computing	3-0-0-0	3	3	SAN
		23ELL31F	Operating Systems	3-0-0-0	3	3	SAN
		23ELL31G	Introduction to Machine Learning	3-0-0-0	3	3	AML

PROGRAMME ELECTIVE II

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
D	PEC	23ELL32A	Energy Storage Systems	3-0-0-0	3	3	PES
		23ELL32B	Modern Illumination Control	3-0-0-0	3	3	PES
		23ELL32C	Advanced Microcontrollers	3-0-0-0	3	3	CAI
		23ELL32D	Introduction to Signal Processing	3-0-0-0	3	3	CAI
		23ELL32E	Wireless Sensor Networks	3-0-0-0	3	3	SAN
		23ELL32F	Introduction to Artificial Intelligence	3-0-0-0	3	3	AML
		23ELL32G	Soft Computing Techniques	3-0-0-0	3	3	AML

PROGRAMME ELECTIVE III

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
D	PEC	23ELL43A	Electric and Hybrid Vehicles	3-0-0-0	3	3	PES
		23ELL43B	Electric Drives	3-0-0-0	3	3	PES
		23ELL43C	Introduction to Robotics	2-1-0-0	3	3	CAI
		23ELL43D	Digital Signal Processing	2-1-0-0	3	3	CAI
		23ELL43E	Software Engineering	3-0-0-0	3	3	SAN
		23ELL43F	Real Time Operating Systems	3-0-0-0	3	3	SAN
		23ELL43G	Machine Learning	3-0-0-0	3	3	AML
		23ELL43H	Web Programming	3-0-0-0	3	3	AML

PROGRAMME ELECTIVE IV

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
A	PEC	23ELL44A	Computer Aided Design of Electrical Machine	3-0-0-0	3	3	PES
		23ELL44B	Smart Grid Technologies	3-0-0-0	3	3	PES
		23ELL44C	HVDC & FACTS	3-0-0-0	3	3	PES
		23ELL44D	Digital Image Processing	3-0-0-0	3	3	CAI
		23ELL44E	Mechatronics	3-0-0-0	3	3	CAI
		23ELL44F	Programming Paradigms	3-0-0-0	3	3	SAN
		23ELL44G	Cryptography	3-0-0-0	3	3	SAN
		23ELL44H	Computer Vision	3-0-0-0	3	3	AML
		23ELL44I	Data Analytics for Electrical Engineers	3-0-0-0	3	3	AML

PROGRAMME ELECTIVE V

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
B	PEC	23ELL45A	Energy Management	3-0-0-0	3	3	PES
		23ELL45B	Solar PV Systems	3-0-0-0	3	3	PES
		23ELL45C	Power System Protection	3-0-0-0	3	3	PES
		23ELL45D	Robotics and Artificial Intelligence	3-0-0-0	3	3	CAI
		23ELL45E	Nonlinear Systems	3-0-0-0	3	3	CAI
		23ELL45F	Cloud Computing	3-0-0-0	3	3	SAN
		23ELL45G	Deep Learning	3-0-0-0	3	3	AML
		23ELL45H	Bioinformatics	3-0-0-0	3	3	AML

PROGRAMME ELECTIVE VI

Slot	Category Code	Course Code	Courses	L-T-P-J	Hours	Credit	Stream Code
C	PEC	23ELL46A	Special Electric Machines	3-0-0-0	3	3	PES
		23ELL46B	Computer Aided Electrical System Design	3-0-0-0	3	3	PES
		23ELL46C	Power Quality	3-0-0-0	3	3	PES
		23ELL46D	Digital Control Systems	3-0-0-0	3	3	CAI
		23ELL46E	Vehicular Networks and Communication	3-0-0-0	3	3	CAI
		23ELL46F	Software Testing	3-0-0-0	3	3	SAN
		23ELL46G	Block Chain Technologies	3-0-0-0	3	3	SAN
		23ELL46H	Data Mining	3-0-0-0	3	3	AML

INSTITUTE ELECTIVE I

Slot	Category Code	Course Code	Course	L-T-P-J	Hours	Credit
E	IEC	23IEL31M	Introduction to Flight Dynamics and Control	3-0-0-0	3	3
		23IEL31N	Introduction to Power Processing	3-0-0-0	3	3
		23IEL31O	Electrical Drives and Control for Automation	3-0-0-0	3	3
		23IEL31P	Artificial Intelligence in Power Systems	3-0-0-0	3	3

INSTITUTE ELECTIVE II

Slot	Category Code	Course Code	Course	L-T-P-J	Hours	Credit
E	IEC	23IEL42M	Architectural Lighting Design and Control	2-1-0-0	3	3
		23IEL42N	Electric Vehicles	3-0-0-0	3	3
		23IEL42O	Process Control and Automation	3-0-0-0	3	3
		23IEL42P	Sustainable Energy Management	3-0-0-0	3	3

LIST OF ELECTIVE COURSES BASED ON MICRO SPECIALIZATION STREAM

CONTROL AND INSTRUMENTATION						
Category	**No.**	**Course**	**Semester**	**L-T-P-J**	**Hours**	**Credit**
PEC	1	Signals and Systems	S5	2-1-0-0	3	3
	2	Biomedical Instrumentation	S5	3-0-0-0	3	3
	3	Advanced Microcontrollers	S6	3-0-0-0	3	3
	4	Digital Image Processing	S6	3-0-0-0	3	3
	5	Introduction to Signal Processing	S6	3-0-0-0	3	3
	6	Introduction to Robotics	S7	2-1-0-0	3	3
	7	Digital Signal Processing	S7	2-1-0-0	3	3
	8	Mechatronics	S8	3-0-0-0	3	3
	9	Robotics and Artificial Intelligence	S8	2-1-0-0	3	3
	10	Non-linear Systems	S8	3-0-0-0	3	3
	11	Vehicular Networks and Communication	S8	3-0-0-0	3	3

SYSTEMS AND NETWORKS						
Category	**No.**	**Course**	**Semester**	**L-T-P-J**	**Hours**	**Credit**
PEC	1	Introduction to Security in Computing	S5	3-0-0-0	3	3
	2	Operating Systems	S5	3-0-0-0	3	3
	3	Wireless Sensor Networks	S5	3-0-0-0	3	3
	4	Software Engineering	S7	3-0-0-0	3	3
	5	Real Time Operating Systems	S7	3-0-0-0	3	3
	6	Web Programming	S7	3-0-0-0	3	3
	7	Programming Paradigms	S8	3-0-0-0	3	3
	8	Cryptography	S8	3-0-0-0	3	3
	9	Cloud Computing	S8	3-0-0-0	3	3
	10	Software Testing	S8	3-0-0-0	3	3
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING						
Category	**No.**	**Course**	**Semester**	**L-T-P-J**	**Hours**	**Credit**
PEC	1	Introduction to Machine Learning	S5	3-0-0-0	3	3
	2	Introduction to Artificial Intelligence	S6	3-0-0-0	3	3
	3	Soft Computing Techniques	S6	3-0-0-0	3	3
	4	Machine Learning	S7	3-0-0-0	3	3
	5	Computer Vision	S8	3-0-0-0	3	3
	6	Data Analytics for Electrical Engineers	S8	3-0-0-0	3	3
	7	Deep Learning	S8	3-0-0-0	3	3
	8	Data Mining	S8	3-0-0-0	3	3
POWER AND ENERGY SYSTEMS						
Category	**No.**	**Course**	**Semester**	**L-T-P-J**	**Hours**	**Credit**
PEC	1	Renewable Energy Conversions	S5	3-0-0-0	3	3
	2	Electromagnetic Theory and Compatibility	S6	3-0-0-0	3	3
	3	Energy Storage Systems	S6	3-0-0-0	3	3
	4	Modern Illumination Control	S6	3-0-0-0	3	3
	5	Electric and Hybrid Vehicles	S7	3-0-0-0	3	3
	6	Electric Drives	S7	3-0-0-0	3	3
	7	Computer Aided Design of Electrical Machine	S8	3-0-0-0	3	3
	8	Smart Grid Technologies	S8	3-0-0-0	3	3
	9	HVDC & FACTS	S8	3-0-0-0	3	3
	10	Energy Management	S8	3-0-0-0	3	3
	11	Solar PV Systems	S8	3-0-0-0	3	3
	12	Power System Protection	S8	3-0-0-0	3	3

B.Tech (MINOR)

Semester	BASKET I				BASKET II				BASKET III				BASKET IV			
	Embedded Systems for Industrial Applications				Architectural Lighting and Electrical System Design				Clean and Sustainable Energy				Electric Vehicle Systems			
	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
S3	23EEL2MA	Microcontrollers and Embedded Systems	3-0-0-0	3	23EEL2MC	Basics of Illumination Science and Lighting Design	3-0-0-0	3	23EEL2ME	Sustainable Energy Systems	3-0-0-0	3	23EEL2MG	Electric Machinery	3-0-0-0	3
S4	23EEL2MB	Hardware Interfacing using Arduino-C Platform	3-0-0-0	3	23EEL2MD	Electric Power Supply and Distribution Systems	3-0-0-0	3	23EEL2MF	Renewable Energy in Power Grids	3-0-0-0	3	23EEL2MH	Power Electronics and Energy Storage Devices	3-0-0-0	3
S5	23EEL3MA	Raspberry Pi - Python Interface for Electrical Engineering	3-0-0-0	3	23EEL3MC	Energy efficiency in Buildings	3-0-0-0	3	23EEL3ME	Solar and Wind Energy Conversion Systems	2-1-0-0	3	23EEL3MG	Hybrid and Electric Vehicles	3-0-0-0	3
S6	23EEL3MB	Cloud Computing for Internet of Things	3-0-0-0	3	23EEL3MD	Electrical System Design and Building services	2-1-0-0	3	23EEL3MF	Smart Grid and Energy Storage Systems	3-0-0-0	3	23EEL3MH	Introduction to Automotive Electrical and Electronic systems	3-0-0-0	3
S7/S8	23EEJ4MA	Mini Project	0-0-6-0	3	23EEJ4MC	Mini Project	0-0-6-0	3	23EEJ4ME	Mini Project	0-0-6-0	3	23EEJ4MG	Mini Project	0-0-6-0	3

B.Tech (HONOURS)

Semester	GROUP I				GROUP II				GROUP III			
	Specialization: Control and Autonomous Systems				Specialization: Machine Learning				Specialization: Smart Grids			
	Course Code	Course	L-T-P-J	Credit	Course Code	Course	L-T-P-J	Credit	Course Code	Course	L-T-P-J	Credit
S4	23ELL2HB	Automatic Control Systems	2-1-0-0	3	23ELL2HD	Basics of Machine Learning	2-1-0-0	3	23ELL2HF	Network Communication in Smart Grid	2-1-0-0	3
S5	23ELL3HA	Process Automation	3-0-0-0	3	23ELL3HC	Mathematics for Machine Learning	3-0-0-0	3	23ELL3HE	Microgrids	3-0-0-0	3
S6	23ELL3HB	Introduction to Navigation and Trajectory planning	2-1-0-0	3	23ELL3HD	Machine Learning Programming	2-1-0-0	3	23ELL3HF	Distributed Generation and Smart Grid	2-1-0-0	3
S7	23ELL4HA	Aircraft Dynamics & Control	3-0-0-0	3	23ELL4HC	Deep Learning	2-1-0-0	3	23ELL4HE	Operation and Control of AC/DC Smart Grids	3-0-0-0	3
S8	23ELJ4HB	Mini Project	0-0-6-0	3	23ELJ4HD	Mini Project	0-0-6-0	3	23ELJ4HF	Mini Project	0-0-6-0	3

** **Honours Group IV of EEE** can be opted by the students of Electrical and Computer Engineering

SYLLABUS

SEMESTER VII

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL40A	CONTROL SYSTEMS	PCC	3	1	0	0	4	2023

i) COURSE OVERVIEW:

This course introduces the fundamentals of control systems, including system modelling and transfer function representation of physical systems. It covers time-domain and frequency-domain analysis techniques for evaluating system stability and performance. The course also introduces the design of controllers and compensators to improve dynamic system behavior.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Understand the fundamental concepts of control systems, components of a control system, and classification of signals and systems.	Understand
CO2	Apply mathematical modelling techniques to derive transfer functions of electrical and mechanical systems.	Apply
CO3	Apply time-domain and root locus techniques to analyse transient response, stability, and performance of control systems.	Apply
CO4	Apply frequency response methods using Bode plots to assess relative stability of control systems.	Apply
CO5	Apply controller and compensator design techniques, including P, PI, PD, PID, lead, lag and lead–lag compensators, to improve system performance.	Apply

iii) SYLLABUS

Introduction to control systems - open-loop and closed-loop control systems - components of a system - Signals and systems - standard test signals.

Mathematical modelling of physical systems - concept of transfer function - block diagram reduction techniques - overall transfer function of interconnected systems.

Time response of control systems - impulse and step response - performance specifications - time response analysis of first-order and second-order systems - effect of system parameters on transient response.

Concept of root locus - effect of pole-zero locations on system performance – Controllers – types - effect of controllers on transient and steady-state response.

Frequency response analysis - Bode plots. Compensators - lead, lag and lead–lag compensators - design of compensators using Bode plot technique.

iv) (a) TEXT BOOKS

1) Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Pearson Education, 2010.
2) Norman S. Nise, Control Systems Engineering, 7th Edition, Wiley India, 2015.
3) I. J. Nagrath and M. Gopal, Control Systems Engineering, 5th Edition, New Age International Publishers, 2010.15

(b) REFERENCES

1) Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 13th Edition, Pearson Education, 2017.
2) John J. D'Azzo, Constantine H. Houpis, and Stuart N. Sheldon, Linear Control System Analysis and Design, McGraw-Hill, 2003.
3) Farid Golnaraghi and Benjamin C. Kuo, Automatic Control Systems, 10th Edition, McGraw-Hill Education, 2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Control Systems and Signals:** Introduction to control systems; open-loop and closed-loop control systems; components of a system; block diagram representation. Signals and systems: linear and non-linear systems; time-invariant and time-varying systems; causal and non-causal systems; standard test signals.	**12**
II	**Mathematical Modelling and Transfer Function:** Mathematical modelling of physical systems; concept of transfer function; derivation of transfer function of mechanical systems (translational and rotational) and electrical systems (RLC); block diagram reduction techniques; overall transfer function of interconnected systems.	**12**
III	**Time Response Analysis:** Time response of control systems; impulse and step response; transient and steady-state response; performance specifications; time response analysis of first-order and second-order systems; effect of system parameters on transient response.	**12**
IV	**Root Locus Technique and Controllers:** Concept of root locus; construction rules; interpretation of root locus plots; effect of pole-zero locations on system performance. Controllers: Proportional (P), Integral (I), Derivative (D), PI, PD and PID controllers; effect of controllers on transient and steady-state response.	**12**
V	**Frequency Response and Compensator Design:** Frequency response analysis; Bode plots; gain margin and phase margin; relative stability. Compensators: need for compensation; lead, lag and lead–lag compensators; design of compensators using Bode plot technique.	**12**
	Total hours	**60**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks

Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL40B	POWER SYSTEM ENGINEERING	PCC	3	1	0	0	4	2023

i) COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of generation, transmission and distribution of electric power. The course also intends to deliver the basic concepts of power system protection including the different types of relays and circuit breakers.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the different forms of power generation schemes, the importance of power system protection and different types of Circuit Breakers and relays	Understand
CO2	Solve problems based on the economics of power generation and power factor improvement	Apply
CO3	Solve for the inductance, capacitance and volume of conductor material required for the various types of power transmission schemes	Apply
CO4	Solve for the various parameters related to overhead transmission lines	Apply
CO5	Solve loading problems related to various power distribution systems and compare AC and HVDC transmission schemes	Apply

iii) SYLLABUS

Introduction - Generation of Electric Power - Overview of conventional generation schemes, Economics of Generation – Terminology - Power Factor Improvement using capacitors.

Power Transmission - Transmission Line Parameters: Resistance, inductance and capacitance of single phase two wire and three phase lines, Modelling of Transmission Lines.

Introduction to overhead transmission lines– Volume of conductor material required - Mechanical Characteristics of transmission lines – Insulators.

HVDC Transmission – Comparison, Types of DC Links - Power distribution systems – DC and AC distribution - Types.

Basics of power system protection – Circuit Breakers - Protective Relays – Principle and types.

iv) (a) TEXT BOOKS

1) B. R. Gupta, *Power System Analysis and Design*, Wheeler Publishers, 7th revised edition, 2005.
2) J. B. Gupta, A course in Electrical Power, Kataria and Sons, 2013 edition.

3) C. L. Wadhwa, Electrical Power System, New Age International Publishers, 1st edition, 2016.
4) Grainer J.G., Stevenson W.D., Power System Analysis, Tata McGraw Hill, 1st edition, 2017.
5) Badri Ram, D. N. Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill, 2nd edition, 1994.

(b) REFERENCES

1) A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar, A *text book on Power System Engineering*, Dhanpat Rai and Co., 2016 edition.
2) I. J. Nagarath & D. P. Kothari, *Modern Power System Analysis*, Tata McGraw Hill, 4th edition, 2011.
3) K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International, New Delhi, 2nd edition, 2016.
4) William D. Stevenson Jr, *Elements of Power System Analysis*, Tata McGraw Hill, 4th edition, 1982.
5) Sunil S. Rao, *Switchgear and Protection*, Khanna Publishers, 2nd edition, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Typical layout of Power System Network. **Generation of Electric Power:** Overview of conventional generation schemes-Hydro, Thermal and Nuclear; Nonconventional Sources-Solar and Wind, Solar Irradiance Prediction and Wind Speed Prediction models using AI. Economics of Generation: Terminology-Load factor, diversity factor, Load curve; Numerical Problems. Need of power factor improvement, Power Factor Improvement using capacitors.	**10**
II	**Power Transmission:** Transmission Line Parameters: Resistance, inductance and capacitance of 1Φ, 2 wire lines-composite conductors. Inductance and capacitance of 3Φ lines: Symmetrical spacing - Numerical Problems. Modelling of Transmission Lines: Classification of lines-short lines-voltage regulation and efficiency-medium lines-nominal T and Π configurations-Ferranti effect.	**14**
III	**Introduction of Overhead transmission:** Conductors -types of conductors -copper, aluminium and ACSR conductors -Volume of conductor required for various systems of transmission. Mechanical Characteristics of transmission lines –Calculation of sag and tension-supports at equal heights. Insulators -Different types - Voltage distribution, grading and string efficiency of suspension insulators. Corona –disruptive critical voltage -visual critical voltage -Factors affecting corona.	**14**

IV	**HVDC Transmission:** Comparison between AC & DC Transmission, Types of HVDC links. **Power distribution systems:** Radial and Ring Main Systems - DC and AC distribution: Types of distributors- bus bar arrangement - Concentrated loading - Methods of solving distribution problems.	**10**
V	**Power System Protection:** Nature, causes and consequences of faults- Need for protection - Essential qualities of protection - Types of protection – Primary and back up protection.AI-based fault detection and classification. **Circuit breakers:** principle of operation - formation of arc - Arc quenching theory - Restriking Voltage - Recovery Voltage, RRRV. Types of Circuit Breakers: Air blast CB, Oil CB, SF6 CB, Vacuum CB, CB ratings. **Protective Relays:** Zones of Protection, Essential Qualities - Classification of Relays - Electro mechanical, Static Relays, Microprocessor Based Relays; Buchholz relay for transformer protection.	**12**
	Total hours	**60**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL40C	INTERNET OF THINGS	PCC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to introduce students to the different architectures used for connected smart devices. This course will enable students to program embedded devices used in different levels of IoT application. It also aims to expose students to design and develop Internet of Things based solution.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the characteristics of IoT and the role of computer networks in IoT.	Understand
CO 2	Classify the different communication standards for IoT applications.	Understand
CO 3	Explain the functionalities and applications of various sensors and transmission of data to cloud-based platforms.	Understand
CO 4	Develop programs for IoT devices using micro-python language.	Apply
CO 5	Develop an IoT based solution for real time applications.	Apply

iii) SYLLABUS

Physical Design of IoT, Logical design of IoT, Design Challenges. Internet Protocols and standards, IP addressing, Physical layer components, Sizing of networks. IoT and M2M Communications, M2M standards, Big Data Analytics. Sensor technologies for IoT, data acquisition using embedded devices, data logging to cloud services-protocols and programming. Embedded devices for IoT: Sensor interfacing and data acquisition using target boards like Raspberry Pi 4B, ARM EMBED, ESP32, Arduino boards-Programming examples for data logging to the cloud using micro python, Blueprint of IOT for Smart Cities. IoT Applications.

iv) (a) TEXT BOOKS

1) Simone Cirani, Internet of things: Architecture, protocols and standards, Wiley, 2019.
2) Charles Bell, MicroPython for the Internet of Things: A Beginner's Guide to programming.
   with Python on Microcontrollers, Apress, 2017.
3) B.K Thripathy, J Anuradha, Internet of things (IoT) - technologies, applications, challenges and solutions, CRC press, 2018.
4) Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill (India) Private Limited, 2017.
5) Peter Waher, Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3, 1st Edition, Packt Publishing, 2018.
6) Handbook of Artificial Intelligence for Smart City Development, Management

Systems and Technology Challenges. Edited By Sandhya Makkar, Gobinath Ravindran, Ripon Kumar Chakrabortty, Arindam Pal

(b) REFERENCES

1) Qusay F. Hassan, Internet of Things A to Z: Technologies and applications, IEEE press, 2018
2) Gary Smart, Practical Python Programming for IoT: Build advanced IoT projects using Raspberry Pi MQTT, RESTful APIs, Web Sockets, and Python 3, Packt Publishing Ltd, 2020
3) Gaston C. Hillar, MQTT Essentials - A Lightweight IoT Protocol, Packt Publishing Ltd, 2017.
4) Alasdair Gilchrist, Industry 4.0 The Industrial Internet of Things, Apress, 2016.
5) David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, First Edition, Cis CO Press, 2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT Protocols, Logical Design of IoT: IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies. Design challenges – power consumption and security issues. **Computer networks**: Internet-protocols and standards-OSI model- TCP/IP protocol suite. IP addressing – IPv4 and IPv6, Physical layer components- Switch, Router, Access point, station, Server, Client, Port, Gateway. Sizing of network- LAN, MAN, WAN.	**10**
II	**IoT and M2M Communications:** Introduction, M2M, M2M applications, Differences between M2M and IoT, M2M standards- Bluetooth-LE, Zigbee, NFC, Wifi and LoRaWAN. Data logging and cloud services- CoAP, MQTT and JSON. Big data analytics (concepts only).	**9**
III	**Sensor technologies for IoT-** Wireless sensor network. Voltage, Current, Speed, Temperature and humidity sensors and data acquisition using embedded devices- block diagram. Data logging to cloud services- protocols and programming.	**8**
IV	**Embedded devices for IoT.** Introduction to Python programming and embedded programming using micro python. Sensor interfacing and data acquisition using target boards like Raspberry Pi 4B, ARM EMBED, ESP32, Arduino boards. Programming examples for data logging to the cloud using micro python like Raspberry Pi 4B, Arduino boards. Blueprint of IOT for Smart Cities (Can be given as Assignment).	**9**

V	**IoT applications:** Energy management and smart grid applications. IoT based home automation, Smart metering for electricity consumers. IoT based weather stations, Agriculture- smart farming, Automobile IoT- Electric vehicles-platform and software, Industrial IoT. Security and Privacy Issues in Smart Cities.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELV48A	Comprehensive Viva Voce	PWS	0	0	2	0	1	2023

i) COURSE OVERVIEW:

The objective of this course is to evaluate the students' basic understanding and application capability in the core domains of their respective engineering branch.

ii) COURSE OUTCOMES

CO1	Apply fundamental concepts from core engineering courses to analyze and solve basic engineering problems relevant to the branch of study.	Apply
CO2	Demonstrate comprehensive technical understanding by articulating engineering concepts, reasoning, and solutions effectively during viva voce examination.	Understand

iii) SYLLABUS

Data Structures: Performance Analysis, Asymptotic Notation, Complexity Calculation of Simple Algorithms, Sparse matrix, Stacks and Queues, Linear Search and Binary Search. Linked List and Memory Management, Trees and Graphs, Sorting and Hashing.

Computer Organization and Architecture: Register transfer logic: inter register transfer, Design of arithmetic logic unit, shifter, accumulator, Arithmetic Algorithms. Pipelining, hazard detection and resolution. Design of the processing unit, control unit, interrupts, DMA.

Object Oriented Programming using Java: Methods, Inheritance, Packages and Interfaces, managing errors and Exceptions, Managing Input/Output Files. Java Library Array List class, Accessing a Collection via an Iterator, Event handling Multithreaded Programming.

Digital Electronics and Logic Design: Number systems and codes, Boolean Algebra and Logic gates, Combinational Logic Circuits, Sequential Logic circuits, State machines, HDL model

Database Management Systems: ER models, Relational Algebra, Structured Query Language (SQL), formation of SQL queries using SQL DML Physical Data organization, Heap files, Indexing, Singe level and multi-level indices, B trees, Hashing and indexing, Different anomalies in designing a database and different types of normalization applied to Databases. noSQL Database, Redis, MongoDB, Arango DB, Cassandra.

Microprocessor and Embedded Systems: Architecture of 8085 microprocessor, Programming 8085, Architecture of Intel 8051 Microcontrollers, Assembly programming for 8051 microcontrollers, Embedded C programs for I/O port, serial port communication, timer/counter, Interrupt programming, interfacing external peripherals, Embedded systems.

Power Electronics and Drives: Power semiconductor devices, characteristics, Drive circuits, Single phase and three phase rectifiers, Inverters, DC-DC converters, AC voltage regulators. Transformers, Autotransformers, DC motor and generator, Induction Motor.

Algorithm Analysis and Design: Analysis of Recursive Algorithms, Advanced Data Structures and Graph Algorithms, Self-Balancing Tree - AVL Trees, DFS and BFS traversals, Topological Sorting, Divide & Conquer and Greedy Strategy, Dynamic Programming, Back

Tracking and Branch & Bound, Control Abstraction, Branch and Bound Algorithm for Travelling Salesman Problem

Control and Instrumentation: Mathematical modelling of electrical and mechanical system, Transfer function, step response of first order and second order, time domain and frequency domain analysis, stability analysis, state space analysis. Transducers, Operational amplifiers.

Power Systems: Electric power generation, Transmission line parameters, modelling of transmission lines, Overhead transmission schemes, HVDC transmission, Power distribution systems, power system protection schemes.

iv) a) TEXTBOOKS

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, 2007.
2. Thomas L. Floyd, Digital Fundamentals, Pearson Education, 10th Edition, 2011.
3. Hamacher C., Z. Vranesic and S. Zaky, "Computer Organization", 5th Edition, McGraw Hill, 2011.
4. Herbert Schildt, Java: The Complete Reference, 8th Edition, Tata McGraw Hill, 2011.
5. Kenneth J. Ayala, The 8051 Microcontroller Architecture, Programming and Application, Cengage Learning, 3rd Edition,2012.
6. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
7. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, Prentice-Hall India (2001).
8. Rashid M H, Power Electronics – Circuits, Devices and Applications, Prentice Hall of India, New Delhi, 4th edition, 2014
9. Bimbra P. S., "Electric Machines", Khanna Publishers, 2nd Edition, 2017
10. Masters, Gilbert M., Renewable and Efficient Electric Power Systems, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.
11. Nagrath and M. Gopal, Control Systems Engineering, New Age International Publishers, 6th Edition, 2018.

b) REFERENCES

1. Samanta D., "Classic Data Structures", 2nd Edition, Prentice Hall India Learning Private Limited, 2009.
2. Donald P. Leach, Albert Paul Malvino, Digital Principles and Applications, Tata Mc Graw Hill, 8th Edition, 2014.
3. Robert Bausiere, Francis Labrique, Guy Seguier Patterson D.A. and J. L. Hennessy, "Computer Organization and Design", 5th Edition, Morgan Kaufmann Publishers, 2013.
4. Y. Daniel Liang, Introduction to Java Programming, 7th Edition, Pearson, 2013.
5. Shibu K. V., "Introduction to Embedded Systems", 2nd Edition, McGraw Hill Education India, 2016.
6. Gupta J. B., "Theory and Performance of Electrical Machines", S K Kataria & Sons, 14th Edition, 2013.
7. Gupta J. B., "A course in Electronic and Electrical Measurement and Instrumentation", S K Kataria & Sons, 13th Edition, 2007
8. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
9. Richard Neapolitan and Kumarss Naimipour, "Foundations of Algorithms", 5th Edition, Jones & Bartlett Learning (2015).

10. Weedy B. M., B. J. Cory, N. Jenkins, J. B. Ekanayake and G. Strbac, Electric Power System, John Wiley & Sons, 2012.
11. Ned Mohan, Tore M. Undeland, William P. Robbins, Power Electronics: Converters, Applications, and Design, Wiley India, 3rd Edition, 2018

v) Course Plan

Module	Contents	No. of hours
I	**Data Structures**	3
	Computer Organization and Architecture	3
II	**Object Oriented Programming using JAVA**	3
	Digital Electronics and Logic Design	3
III	**Database Management Systems**	3
	Microprocessor and Embedded Systems	3
IV	**Power Electronics and Drives**	3
	Algorithm Analysis and Design	3
V	**Control and Instrumentation**	3
	Power Systems	3
	Total	**30 hours**

vi) COURSE GUIDELINES AND EVALUATION

i) The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum. Mock tests, mock viva voce sessions, technical discussions may be conducted by the faculty in charge during the hours assigned for the course.

ii) **Total marks: 50**

Continuous internal evaluation-25 marks

Attendance – 5 marks

Multiple choice questions test and comprehensive viva (minimum 2 each) - 20 marks

Final viva voce examination-25 marks

The mark will be treated as internal and should be uploaded along with internal marks of other courses.

The final viva voce examination shall be conducted by a panel of two evaluators. The panel shall consist of one senior faculty member from the Department and an expert from Industry/research institute/academia or two senior faculty members from the Department.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELJ48A	PROJECT	PWS	0	0	10	0	5	2023

i) COURSE OVERVIEW:

The aim of this course is to apply engineering knowledge in solving practical problems, to foster innovation in design of products, processes or systems, and to develop creative thinking in finding viable solutions to engineering problems. The course is mainly intended to evoke the innovation and invention skills of a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation.

Desirable: The project outcome should be published in a peer-reviewed journal or presented at a conference, or a patent application should be filed.

It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Apply multidisciplinary knowledge to model and solve real world problems.	Apply
CO 2	Apply innovative and creative problem-solving to develop sustainable and socially relevant products, processes, or technologies.	Create
CO 3	Exhibit effective teamwork and leadership skills in diverse environments, with the ability to comprehend and carry out designated responsibilities.	Apply
CO 4	Execute tasks by planning effectively and utilizing available resources to meet deadlines, while adhering to ethical and professional standards.	Apply
CO 5	Effectively document, present, and communicate technical and scientific outcomes in professional written and verbal formats.	Apply

iii) Evaluation Guidelines

Total: 100 marks (Minimum required to pass: **50** Marks).

● Project progress evaluation by guide: **20** Marks.

● Two interim evaluations by the Evaluation Committee: **30** Marks (15 marks for each evaluation).

● Final evaluation by the Final Evaluation committee: **30** Marks

● Quality of the report evaluated by the evaluation committee: **20** Marks

Interim Evaluation:

The Evaluation committee comprises of HoD or a senior faculty member, Project coordinator and Project supervisor.

Final Evaluation:

The final evaluation committee comprises of Project coordinator, domain expert from the Department and expert from Industry/research/academic Institute / senior faculty from a sister department.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELI48A	INTERNSHIP	PWS	0	0	-	0	5	2023

i) COURSE OBJECTIVES

The internship is an integral component of the undergraduate programme aimed at providing students with immersive learning through practical exposure in industry, research organizations, or academic institutions.

BENEFITS OF INTERNSHIP

Benefits to Students

- Provides practical exposure to real-world industrial and organizational environments, enabling the application of theoretical knowledge gained in classrooms.
- Enhances professional competencies such as communication, teamwork, time management, interpersonal skills, and workplace ethics.
- Facilitates the development of technical and domain-specific skills, thereby strengthening overall professional readiness.
- Assists students in assessing their career interests and determining the suitability of a particular industry or profession.
- Improves employability by strengthening profiles for placements, higher education, and potential recruitment by the host organization.
- Encourages professional networking and relationship - building with industry experts and peers.
- Offers an opportunity to evaluate the organization and work culture before committing to full-time employment.

Benefits to the Institute

- Strengthens industry - academia collaboration.
- Facilitates smoother and more effective placement processes.
- Enhances institutional credibility and brand value.
- Supports student engagement and retention.
- Enables curriculum updates based on industry and student feedback.
- Improves the overall teaching - learning process through industry relevance.

Benefits to the Industry

- Provides access to a pool of motivated, job-ready students who can contribute immediately.
- Offers a cost-effective mechanism to evaluate and recruit potential employees.
- Enables the availability of a flexible workforce for temporary, project-based, or seasonal requirements.
- Brings fresh perspectives and innovative approaches to problem-solving.
- Enhances organizational visibility and employer branding within academic institutions.
- Strengthens corporate image by contributing to education and skill development.

TYPES OF INTERNSHIPS

- Industry Internship with/without Stipend
- Government / PSU Internship (BARC/Railway/ISRO etc.)
- Internship with prominent education/ Research Institutes
- Internship with Incubation centres /Start-ups

ii) COURSE OVERVIEW

Students can undertake an internship at an industry, research organization, or a reputed academic institution with prior approval of the respective Head of the Department.

The internship is designed to promote meaningful skill development through structured, outcome-driven experiential learning. It shall focus on clearly defined technical competencies, such as domain-specific skills, software proficiency, exposure to industry-standard tools, and structured engineering problem-solving tasks. The learning objectives of the internship, along with the expectations of the host organization and the academic requirements of the institution, shall be clearly defined in consultation with the host organization and mutually agreed upon prior to the approval of the internship.

Each student shall be assigned a faculty guide/supervisor for monitoring and evaluation. The internship shall be relevant to the student's stream of study and can be carried out in Semester **VII** or Semester **VIII**, as specified by the Department, for a minimum duration of **three months.**

A student shall be permitted to undertake the internship only after the respective semester registration. During the internship period, any other courses or academic activities shall be pursued in online mode or as specified by the Department, to ensure timely fulfillment of all academic requirements.

iii)COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply theoretical knowledge and engineering principles to practical problems encountered in professional practice.	Apply
CO2	Demonstrate technical competence and understanding of tools, techniques, and processes relevant to the chosen field of specialization.	Apply
CO3	Analyse social, environmental, economic, safety, and administrative factors influencing industrial operations and decision-making processes.	Analyze
CO4	Communicate effectively through technical reports, presentations, and professional interactions in an industrial or research environment.	Apply
CO5	Apply professional ethics, teamwork, and adaptability while performing assigned tasks in a multidisciplinary work setting.	Apply

iv) GUIDELINES FOR STUDENTS

- Duration of internship is three to six months (One semester).
- Students may undertake mini projects, case studies, or related technical tasks during the internship with the prior approval of the competent authority at the host organisation.
- Students shall strictly adhere to the rules, regulations, code of conduct, and working hours prescribed by the host organisation.

- Prior permission shall be obtained from the host organisation before using or reproducing any data, documents, drawings, photographs, or proprietary information for academic purposes.
- Students shall follow all ethical practices, confidentiality requirements, and Standard Operating Procedures (SOPs) of the host organisation.

- Students shall comply with all health, safety, and environmental guidelines prescribed by the host organisation during the internship period.
- Students shall maintain regular contact with the assigned faculty guide/supervisor and submit weekly progress updates on the work carried out.
- Each student shall maintain a diary/logbook recording daily activities, learning outcomes, and progress throughout the internship period.
- On completion of the internship, students shall submit the following documents to the Department:
  - ✓ Internship report detailing the work carried out and learning outcomes
  - ✓ Internship Completion Certificate issued by the host organisation
  - ✓ Feedback from the employer
  - ✓ Proof of stipend received, if applicable

v) ASSESSMENT PATTERN

The marks awarded for the Internship will be based on the following:

(i) Evaluation done by the industry,
(ii) Student's diary,
(iii) Internship report, and
(iv) Internship viva voce.

Continuous Assessment		
Student's diary/ Daily Log	:	25 marks
Evaluation done by the industry	:	25 marks
Total Continuous Assessment	:	**50 marks**
Final Assessment		
Internship Report	:	25 Marks
Internship Viva Voce	:	25 marks
Total Final Assessment	:	**50 marks**
TOTAL	:	**100 marks**

Student's Diary/ Daily Log

The purpose of maintaining a daily diary is to cultivate systematic documentation habits and to encourage students to record observations, impressions, information gathered and

suggestions, if any, during the internship period. The diary shall contain a day-to-day record of activities, learning experiences, technical details, and relevant sketches or drawings related to the work carried out. The daily diary shall be signed regularly by the industry supervisor and shall be verified and ratified by the faculty guide during the interim review.

The interim review shall be conducted midway through the internship by the Internship Review Committee, comprising the internship coordinator, faculty supervisor, and a senior

faculty member of the Department. The review may be conducted in online or offline mode, based on the feasibility of the student's physical presence on campus.

Internship Report

On completion of the internship, each student shall prepare and submit a comprehensive internship report to the faculty supervisor. The report shall present a systematic account of the activities undertaken, observations made and knowledge gained during the training period. Students may consult the industry supervisor during the preparation of the final report, subject to compliance with the confidentiality policies and norms of the host organisation. The completed report shall be duly certified and signed by the Industry Supervisor, Faculty guide and the Head of the Department.

The internship report shall be evaluated based on the following criteria:

- Originality and technical content
- Adequacy, clarity and relevance of the written presentation
- Organization, format, use of drawings, sketches, language and overall style
- Variety and relevance of learning experiences documented
- Demonstration of practical applications and linkage with theoretical concepts covered in the curriculum

Evaluation done by the industry

The performance of the student during the internship shall be evaluated by the industry supervisor or the person-in-charge using a prescribed evaluation format provided by the institution. The evaluation shall cover key parameters such as professional behaviour, technical competence, learning ability, initiative, quality of work, communication skills, teamwork, discipline, time management, and overall professional attitude.

The faculty guide shall share the evaluation format with the host organization and coordinate the assessment process. The completed evaluation form shall be duly signed and sealed by the industry supervisor and submitted to the Department as part of the internship assessment records.

Internship Viva Voce

The viva voce examination shall be conducted by the Internship Review Committee. The committee shall assess the student's understanding of the internship work, technical competence, learning outcomes, and professional orientation.

PROGRAMME ELECTIVE III

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43A	ELECTRIC AND HYBRID VEHICES	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamentals and trends of electric, hybrid, and autonomous vehicles, including energy storage, electric machines, charging systems, and communication protocols.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply hybrid electric vehicle architecture principles to determine the overall vehicle performance metrics.	Apply
CO2	Illustrate the fundamental principles and provide a comparative study of diverse Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV) powertrain architectures.	Understand
CO3	Explain the architecture and operational characteristics of propulsion systems utilized in electric and hybrid-electric transport.	Understand
CO4	Outline the most effective energy storage solutions and high-performance battery chargers for vehicle applications.	Understand
CO5	Summarize various communication protocols and technologies used in vehicle networks and high efficiency battery charging infrastructures for automotive applications.	Understand

iii) SYLLABUS

Conventional Vehicles, Basics of vehicle performance, Basic Architecture of hybrid traction, Electric Drive train, Power flow control.
Electric Propulsion unit, Configuration and control of DC motor drives and Induction Motor drives.
Energy Storage Requirements in Hybrid and Electric Vehicles, Battery modelling.
Vehicle Communication protocols, Functions of Control Pilot and Proximity Pilot.

iv) (a) TEXT BOOKS

1) Iqbal Husain: *Electric and Hybrid vehicles: Design Fundamentals,* CRC press, 3rd Edition 2003.
2) Ehsani M., *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2005.
3) Gianfranco Pistoia, *Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market,* Elsevier,2010.
4) Chan C. C. and Chau K. T., *Modern Electric Vehicle Technology,* OXFORD University Press, 2001.

(b) REFERENCES

1) James Larminie, John Lowry, *Electric Vehicle Technology Explained*, 2nd Edition Wiley 2003.
2) Fuhs A. E., *Hybrid Vehicles and the Future of Personal Transportation,* CRC Press, 2009.
3) Chris Mi , Abul Masrur M., *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives,* 2nd Edition, John Wiley & Sons Ltd,2017.
4) Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer, 2013.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Hybrid Electric Vehicles**: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. **Autonomous Vehicles:** Levels of automation, significance & effects of automation in vehicles	**10**
II	**Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies. **Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. Comparative insights into BEV, HEV, PHEV and Fuel Cell EV architectures.	**8**
III	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles. **DC Drives**: Review of Separately excited DC Motor control – Speed and torque equations -Closed loop control of speed and torque. **Induction motor Drives**: Voltage and frequency control-Field Oriented Control (FOC) (Block diagram only).	**9**
IV	**Energy Storage**: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System, Battery Modelling, Fuel Cell based energy storage systems -Hybridization of different energy storage devices. **Overview of Electric Vehicle Battery Chargers** - On-board chargers, Electric Vehicle Supply Equipment (EVSE) - Grid to vehicle power flow block schematic diagrams.	**9**

V	**Types of charging stations** - AC Level 1 & 2, DC - Level 3 –V2G concept. **Vehicle Communication protocols**: Need and requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY- CAN Architecture-Power line communication (PLC) in EV.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43B	Electric Drives	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides a comprehensive understanding of electric drive systems, focusing on their design, control, and application in modern electrical and computer engineering domains. The course provides fundamentals of drives systems, details of various DC and AC drives and their applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply the fundamental in dynamics and control of electric drives	Apply
CO2	Apply the appropriate configuration of controlled rectifiers for the speed control of DC motors	Apply
CO3	Model chopper-fed DC motor drive and identify various quadrants of operation	Apply
CO4	Explain the various speed control techniques of induction motors	Understand
CO5	Explain the different speed control methods of synchronous motor drives and various applications of Electric drives.	Understand

iii) SYLLABUS

Block diagram of electric drives, four quadrant operation of drives, Equivalent values of drive parameters- - steady state stability.

Rectifier control of DC drives- separately excited DC motor drives using single-phase and three phase-controlled rectifiers - dual converter control of DC motor.

Chopper control of DC drives -one quadrant, two quadrant and four quadrant chopper drives - -closed loop speed control for separately excited dc motor.
Three phase induction motor drives: Stator voltage control - Stator frequency control – v/f control - static rotor resistance speed control– static slip power recovery speed control. - space vector modulation

Synchronous motor drives self-controlled mode – load commutated CSI fed synchronous motor. Permanent magnet AC motor drives-Brushless DC motor drive=applications of Electric Drives

iv) (a) TEXT BOOKS

1) Gopal K. Dubey, *Fundamentals of Electrical Drives*, 2nd Edition, Narosa Publishing House, 2001.
2) Vedam Subrahmanyam, *Electric Drives: Concepts and Applications*, Tata McGraw Hill, 2002.

3) Bimal K. Bose, *Modern Power Electronics and AC Drives*, Prentice Hall, 2002.

(b) REFERENCES

1) R. Krishnan, *Electric Motor Drives: Modeling, Analysis and Control*, Prentice Hall, 2001.
2) Mohamed A. El-Sharkawi, *Fundamentals of Electric Drives*, Cengage Learning, 2018.
3) Austin Hughes and Bill Drury, *Electric Motors and Drives: Fundamentals, Types and Applications*, 4th Edition, Elsevier, 2013.
4) W. Leonhard, *Control of Electrical Drives*, Springer, 3rd Edition, 2001.
5) MATLAB/Simulink Documentation – *Simscape Electrical™ Toolbox*, MathWorks

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Electric Drives :** Introduction to electric drives – block diagram – advantages of electric drives – dynamics of motor load system, fundamental torque equations, types of load – classification of load torque, four quadrant operation of drives, Equivalent values of drive parameters- steady state stability.	**9**
II	**Rectifier control of DC drives**- Review of DC motor types, separately excited DC motor drives using controlled rectifiers- single-phase fully controlled rectifier fed drives (discontinuous and continuous mode of operation), single-phase semi converter fed drives (continuous mode of operation) – three phase fully controlled converter fed drives (continuous mode of operation) - dual converter control of DC motor - circulating current mode.	**9**
III	**Chopper control of DC drives** - single quadrant chopper drive-motoring and regenerative braking control of separately excited dc motors -two quadrant and four quadrant chopper drives - chopper fed DC series motor drive - closed loop speed control for separately excited dc motor. Matlab simulation of chopper fed dc drives.	**9**
IV	**Three phase induction motor drives:** Stator voltage control - Stator frequency control – v/f control - static rotor resistance speed control– static slip power recovery speed control scheme for speed control below and above synchronous speed. VSI fed Induction motor drives, Concept of space vector modulation	**9**
V	**Synchronous motor drives** – v/f control – open loop control – self-controlled mode – load commutated Inverter fed synchronous motor drive. Permanent magnet AC motor drives-Sinusoidal PMAC motor drives, Brushless DC motor drive.	**9**

	Applications of Electric Drives: Digital control of electric drives using microcontrollers and DSPs. Drives in Electric Vehicles and Industrial Automation.	
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43C	INTRODUCTION TO ROBOTICS	PEC	2	1	0	0	3	2023

i) COURSE OVERVIEW: This course introduces students to the foundational principles and technologies that enable robotic systems. It provides a multidisciplinary approach to explore the modeling, control, and application of robots.

i) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Identify the anatomy and specifications of robots for typical application.	Apply
CO2	Select the appropriate sensors, grippers and actuators for particular robotic application.	Apply
CO3	Solve forward and inverse kinematics of robotic manipulators.	Apply
CO4	Develop trajectories in joint space and Cartesian space.	Apply
CO5	Develop the dynamic model of a given robotic manipulator and its control strategy.	Apply
CO6	Explain mobile robot types and advances in AI in robotics	Understand

ii) SYLLABUS

Definitions, Types of Robots, Anatomy of a robotic manipulator, open kinematic vs closed kinematic chain, degrees of freedom, Robot considerations for an application, Robot Applications.

Sensors and Actuators Sensor classification, Internal sensors, External sensors, Selection of sensors. Actuators for robots, Electric actuators, Linear actuators, selection of motors; Hydraulic actuators, Pneumatic Actuators.

Robot configurations, features of SCARA, PUMA Robots; Classification of robots based on motion control methods and drive technologies

Classification of End effectors. Kinematics and Motion Planning - Robot Coordinate Systems, Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward and inverse Kinematics of typical robots upto 3 DOF, Motion Planning.

Dynamics and Control of Robots - Dynamic model of a robot using Lagrange's equation, dynamic modeling of 1 DOF robot, PID control of a single link manipulator- Computed torque control.

Mobile Robot Types, Introduction to AI in robotics

iii) (a) TEXT BOOKS

1) S K Saha, *Introduction to Robotics*, Tata McGraw Hill, 2nd edition, 2017.

2) Robert. J. Schilling, *Fundamentals of robotics – Analysis and control*, Prentice Hall of India, 1st edition, 1990.
3) R K Mittal and I J Nagrath, *Robotics and Control*, Tata McGraw Hill, New Delhi, 1st edition, 2003.
4) John. J. Craig., *Introduction to Robotics* (*Mechanics and control*), Pearson Education Asia, 3rd edition, 2004.
5) Saeed B. Nikku, *Introduction to Robotics*, Pearson Education, 2nd edition, 2010.
6) Rachid Manseur, *Robot Modeling and Kinematics*, Lakshmi publications, 2nd edition, 2008.

(b) REFERENCES

1) Ashitava Ghosal, *Robotics-Fundamental concepts and analysis*, Oxford University press, 2006.
2) S. R. Deb, *Robotics Technology and Flexible Automation*, 2nd edition, 2017.
3) Boltans W., *Mechatronics*, Pearson Education, 6th edition, 2016.

iv) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Definitions - Robots, Robotics; Types of Robots- Manipulators, Mobile Robots - wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator - links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom. **Robot specifications for an application** - number of axes, work volume, capacity & speed, stroke & reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control. **Robotic Applications:** Industrial Applications - Material handling, welding, Spray painting, Machining. Non-industrial - medical, mining, space, defense, security, domestic, entertainment.	**8**
II	**Sensor for robots** - classification - touch, force, proximity, vision sensors. Internal sensors - Position sensors, velocity sensors, acceleration sensors, Force sensors. Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors. **Actuators for robots -** classification - Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors Hydraulic actuators - Components and typical circuit, advantages and disadvantages; Pneumatic Actuators - Components and typical circuit, advantages and disadvantages.	**8**
III	**Grippers for Robots-** Classification - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, factors affecting selection of grippers. **Robot classification**	**9**

	Classification based on Robot configurations - PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots. Classification of robots based on motion control methods and drive Technologies.	
IV	**Robot Coordinate Systems-** Fundamental and composite rotations, homogeneous coordinates and transformations. **Robot Kinematics** - Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward Kinematic analysis of a typical robots up to 3 DOF. Inverse Kinematics of a typical 3 DOF robot. **Motion Planning** - joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends; Cartesian space planning, Point to point vs continuous path planning.	**9**
V	**Dynamics of Robots** Dynamics - Dynamic model of a robot using Lagrange's equation, dynamic modeling of 1 DOF robot **Control Techniques -** Transfer function and state space representation, Performance and stability of feedback control. PID control of a single link manipulator, selection of PID controller gains; nonlinear nature of manipulators, and need for nonlinear control techniques, Computed torque control, Gravity control. **Mobile robot types**: wheeled, legged, aerial overview (non-depth), Kinematic configuration of differential drive. **Introduction to AI in robotics**: learning-based control, collaborative robots (Cobots), Industry 4.0	**11**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43D	DIGITAL SIGNAL PROCESSING	PEC	2	1	0	0	3	2023

i) COURSE OVERVIEW: This course covers the fundamentals of Discrete Fourier Transform (DFT) and its computation using both the direct method and the Fast Fourier Transform (FFT). It also introduces techniques for designing Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters based on given specifications. In addition, the course provides a detailed analysis of finite word-length effects in fixed-point digital signal processing systems and discusses the architecture of a digital signal processor.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Apply Discrete Fourier and Fast Fourier transforms on discrete time signals.	Apply
CO2	Model various structures for realization of IIR and FIR discrete time systems.	Apply
CO3	Develop IIR filters using impulse invariant and bilinear transformation methods.	Apply
CO4	Develop FIR filters using frequency sampling method and window function method.	Apply
CO5	Explain the architecture of digital signal processors and finite word length effects.	Understand

iii) SYLLABUS

Discrete-Fourier Transform - Frequency domain sampling - Discrete Fourier transform (DFT), inverse DFT (IDFT -Filtering of long data sequences – Fast Fourier transform (FFT). Realization of IIR and FIR Systems - conversion of lattice to direct form and vice versa- signal flow graphs and transposed structures. IIR Filter Design - frequency transformation in analog domain - design of LP,
HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation. FIR Filter Design and Representation of Numbers - IEEE 754 32-bit single precision floating point representation. Finite Word Length Effects and Digital Signal Processors – architecture based on Harvard architecture (block diagram) -applications of DSP.

iv) (a) TEXT BOOKS

1) John G. Proakis & Dimitris G. Manolakis, Digital Signal Processing Principles, Algorithms & Applications, Fourth edition, Pearson Education / Prentice Hall, 2007.
2) P. Ramesh Babu, Digital Signal Processing, Fourth Edition Scitech Publications (India) Pvt Ltd, 2011.
3) Emmanuel C. Ifeachor, & Barrie W. Jervis, Digital Signal Processing, Pearson Education / Prentice Hall, 13th Edition, 2013.
4) Alan V. Oppenheim, Ronald W. Schafer & Hohn. R. Back, Discrete Time Signal Processing, Pearson Education, 2nd edition, 2005.
5) Sanjit K. Mitra, "Digital Signal Processing, A Computer based Approach", Tata McGraw-Hill, 4 th Edition, 2017.

(b) REFERENCES

1) Li Tan, *Digital Signal Processing, Fundamentals & Applications*, Academic Press,1st Edition, 2008.
2) D.Ganesh Rao&Vineeta P Gejji, *Digital Signal Processing, A simplified Approach*, Sanguine Technical Publishers, 2nd Edition, 2008.
3) Johny R. Johnson, *Introduction to Digital Signal Processing*, PHI, 2006.
4) S. K. Mitra, *Digital Signal Processing, A Computer Based Approach*, Tata McGraw-Hill, 1998.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Discrete-Fourier Transform**- Review of signals and systems- Frequency domain sampling - Discrete Fourier transform (DFT), inverse DFT (IDFT) - properties of DFT -Filtering of long data sequences - over-lap save method, over-lap add method. Fast Fourier transform (FFT)- radix -2 decimation-in-time FFT (DIT-FFT) algorithm, Radix-2 decimation-in-frequency FFT (DIF-FFT) algorithm.	**9**
II	**Realization of IIR and FIR Systems-**Introduction to FIR and IIR systems - Realization of IIR systems direct form 1, direct form 2, cascade form, parallel form, lattice structure for all-pole system, lattice-ladder structure conversion of lattice to direct form and vice versa- signal flow graphs and transposed structures Realization of FIR systems direct form, cascade form, lattice structure, linear phase realization.	**9**
III	**IIR Filter Design** -Conversion of analog transfer function to digital transfer function: impulse invariant transformation and bilinear transformation. Warping effect. Design of IIR filters: low-pass, high pass, band-pass, band-stop filters- design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation.	**9**

IV	**FIR Filter Design: -**Impulse response of ideal low pass filter-Design of FIR filter (LP, HP filters) using window functions: Rectangular, Hanning and Hamming windows, FIR filter (LP, HP filters) design based on frequency sampling approach. **Representation Of Numbers:** fixed point representation - floating point representation –IEEE 754 32-bit single precision floating point representation. **Introduction to FDA Toolbox in MATLAB:** Design of filters using FDA toolbox (**Demo/Assignment only**).	**9**
V	**Finite Word Length Effects** -Finite word length effects in digital Filters: input quantization - quantization overflow- techniques to prevent overflow - product quantization error-rounding and truncation, round-off noise power, limit cycle oscillations, zero input limit cycle oscillations, overflow limit cycle oscillations, signal scaling. **Digital Signal Processors**: Digital signal processor architecture based on Harvard architecture (block diagram), comparison of fixed-point and floating-point processor applications of DSP.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43E	SOFTWARE ENGINEERING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides students with a thorough understanding of software engineering by integrating theoretical foundations with practical applications. It covers a range of software process models, including both traditional and agile methodologies, while highlighting the significance of human factors and project management. Students will gain skills in eliciting, documenting, and validating software requirements; designing effective architectures using UML, design patterns, and UX principles; and developing and rigorously testing Java-based applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain various software process models and their impact on software development.	Understand
CO2	Illustrate, document, and validate comprehensive software requirements.	Understand
CO3	Develop software architectures and component-level designs that ensure maintainability and usability.	Apply
CO4	Apply software testing techniques and quality assurance practices to ensure the reliability and effectiveness of software systems.	Apply
CO5	Explain software quality assurance principles, configuration management processes, emerging trends and DevOps practices to ensure software reliability and maintainability.	Understand

iii) SYLLABUS

Software process models – Waterfall, Prototyping, Evolutionary, Unified, Agile – Agile teams and human aspects of software engineering. Requirement engineering – Gathering, negotiating, monitoring, and validating requirements – Scenario-based, class-based, functional, and behavioral modeling. Software design concepts – Architectural design, component-level design, user experience design, design patterns, and best practices. Software testing – Verification and validation, unit and integration testing, web application testing, white-box and black-box testing, review techniques, and test automation. Software quality assurance – Statistical SQA, Six Sigma, ISO 9000 standards, configuration management, version control, and risk management. DevOps practices – Continuous integration, continuous deployment, and software maintenance.

iv) (a) TEXT BOOKS

1) Roger S. Pressman, Bruce R. Maxim (2020), Software Engineering: A

Practitioner's Approach, Ninth Edition, McGraw-Hill Education, ISBN 978 – 1 – 260 – 54800 – 6.
2) Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.
3) Ian Sommerville (2016), Software Engineering, Tenth Edition, Pearson Education Ltd, ISBN 10: 1–292–09613–6.

(b) REFERENCES

1) Rajib Mall (2014), Fundamentals of Software Engineering, 4th edition, PHI Learning Pvt Ltd, ISBN: 978–81–203–4898–1.
2) Rod Stephens (2015), Beginning Software Engineering, John Wiley & Sons, Inc., ISBN: 978–1–118–96914–4.
3) Carlo Ghezzi, Mehdi Jazayari, Dino Mandrioli (2015), Fundamentals of Software Engineering, Second Edition, PHI, ISBN: 97889332555396, 9332555397.
4) Bernd Bruegge and Allen Dutoit (2013), Object-Oriented Software Engineering: Practical Software Development Using UML, Patterns, and Java, 3rd edition, Pearson Education, ISBN: 1292037091, 9781292037097.
5) Robert K. Wyzocki (2013), Effective Project Management, 7th edition, WILEY – Dreamtech India Pvt. Ltd, ISBN: 978–1–118–72916–8.

v) COURSE PLAN

Module	Contents	No. of hours
I	Software Engineering Fundamentals–The Nature of Software – Software Process Models: Waterfall Model – Prototyping Process Model – Evolutionary Process Model – Unified Process Model – Agile Process Models – Agile Teams and Frameworks: Scrum – Other Agile Frameworks – Recommended Process Models – Human Aspects of Software Engineering – Professional Ethics in Software Development – Introduction to Software Project Management.	**8**
II	Requirements Engineering and Modeling – Requirement Engineering: Establishing the Groundwork – Requirements Gathering Techniques – Developing Use Cases – Building the Analysis Model – Negotiating Requirements – Requirements Monitoring – Validating Requirements – Modeling Techniques: Scenario-Based Modeling – Class-Based Modeling – Functional Modeling – Behavioral Modeling – Requirements Documentation and Management – Introduction to Requirements Management Tools.	**9**
III	Software Design Concepts – Design Process: Design Concepts – Design Models – Architectural Design: Software Architecture – Agility and Architecture – Architectural Styles – Architectural Design Process – Component-Level Design: Designing Class-Based Components – Conducting Component-Level Design – Specialized Component-Level Design – Component Refactoring – User Experience (UX) Design: User Experience Design Elements – The	**10**

	Golden Rules of UI Design – User Interface Analysis and Design – User Experience Analysis – Design Evaluation – Usability and Accessibility Considerations – Introduction to Design Patterns.	
IV	**Software Testing and Quality Assurance –** Fundamentals of Testing: Verification and Validation – Unit Testing – Integration Testing – Testing Web Applications: Content Testing – User Interface Testing – Component-Level Testing – Navigation Testing – Configuration Testing – Security Testing – Performance Testing – Testing Techniques: White Box Testing – Black Box Testing – Review Techniques: Informal and Formal Technical Reviews – Introduction to Test Automation Tools.	**9**
V	**Software Quality Assurance and Configuration Management** – Software Quality Assurance (SQA): Statistical Software Quality Assurance – Six Sigma and ISO 9000 Quality Standards – Software Configuration Management (SCM): SCM Process and Activities – Version Control Systems – Change Management – Risk Management in Software Projects – Introduction to DevOps Practices – Continuous Integration and Continuous Deployment (CI/CD). **Emerging Trends** (concept only) - AI-assisted software development (GitHub Copilot, automated testing), Low-code / No-code platforms, Green software engineering (energy-efficient software)	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43F	REAL TIME OPERATING SYSTEMS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: To understand RTOS, its basic structure, building blocks, various operations and to summarize the different scheduling algorithms used in RTOS.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Summarize the key characteristics, components, and task management techniques in real-time operating systems, including synchronization and interrupt handling.	Understand
CO2	Explain various real-time scheduling algorithms and techniques for managing task dependencies and compare dynamic and static scheduling approaches in real-time systems.	Understand
CO3	Develop and integrate inter-task communication mechanisms and synchronization techniques in real-time systems, addressing issues like deadlock, live lock, and priority inversion.	Apply
CO4	Apply RTOS kernel design, memory management, and file system implementation to a case study of real-time systems like MicroC/OS-II or FreeRTOS.	Apply
CO5	Infer real-world applications of RTOS in industries such as automotive, aerospace, and IoT, and compare FreeRTOS with commercial RTOS for embedded system integration.	Understand

iii) SYLLABUS

Introduction to Real-Time Operating Systems: RTOS characteristics, task states, task synchronization (semaphores, message queues), interrupt handling.

Task Scheduling in Real-Time Systems: Aperiodic and periodic scheduling (EDF, RMS, DMS), task precedence constraints, dynamic vs static scheduling.

Inter-Task Communication and Synchronization: Message queues, pipes, event registers, synchronization (semaphores, mutexes), deadlock and priority inversion.

RTOS Design and Implementation: RTOS kernel structure, memory management, task scheduling, case studies (MicroC/OS-II or FreeRTOS).

Real-Time Systems Applications and Commercial RTOS: FreeRTOS, RT Linux, control system applications (e.g., adaptive cruise control), real-time networking protocols (CAN, TCP/IP).

iv) (a) TEXT BOOKS

1) Phillip A. Laplante, Real-Time Systems: Design and Analysis, 4th edition, Wiley, 2011.
2) Frank Vahid and Tony Givargis, Embedded Systems Design: A Unified Hardware/Software Introduction, Wiley India Pvt. Limited, 2006.
3) Albert M. K. Cheng, Real-Time Systems: Scheduling, Analysis, and Verification, Wiley India Pvt. Limited, 2002.
4) Jean J. Labrosse, MicroC/OS-II: The Real-Time Kernel, 2nd edition, McGraw Hill, 2002.

(b) REFERENCES

1) Rajib Mall, Real-Time Operating Systems: Concepts and Practice.
2) FreeRTOS: Real-Time Operating System by Richard Barry (Official FreeRTOS book).
3) Jonathan W. Valvano, Designing Embedded Systems and the Internet of Things (IoT) with the ARM mbed.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Real-Time Operating Systems:** Definition and characteristics of Real-Time Systems**,** Types of Real-Time Systems (Hard vs Soft vs Firm)**,** Structure of RTOS and key components (kernel, scheduler, memory management). Task Management: Task States: Ready, Running, Blocked, Suspended Task Synchronization Techniques: Semaphores, Mutexes, Message Queues. Interrupt Handling: Concept of Interrupts and Exceptions in RTOS, Handling Hardware and Software Interrupts, Priority of Interrupts and Nested Interrupts.	**9**
II	**Task Scheduling in Real-Time Systems:** Scheduling Algorithms: Aperiodic Task Scheduling: Earliest Deadline First (EDF), Least Laxity First (LLF). Periodic Task Scheduling: Rate Monotonic Scheduling (RMS), Deadline Monotonic Scheduling (DMS). Precedence Constraints in Scheduling: Handling Task Dependencies and Precedence Constraints (EDF with precedence), Critical Path Analysis in Task Scheduling. Dynamic vs Static Scheduling: Comparison and analysis of dynamic and static scheduling algorithms in real-time systems.	**9**

III	**Inter-Task Communication and Synchronization:** Inter-Task Communication Mechanisms: Message Queues, Pipes, and Event Registers-Signals and Shared Memory in Real-Time Systems, Synchronization in Real-Time Systems: Semaphores (Counting and Binary), Mutexes and their usage in preventing race conditions, Producer-Consumer Problem in RTOS Real-Time Systems Communication Challenges: Deadlock and Livelock Prevention-Priority Inversion Problem and Solutions	**9**
IV	**Real-Time Operating System Design and Implementation**: RTOS Kernel Design: Kernel Structure and Components (Scheduler, Resource Management), Task Management and Kernel Primitives RTOS Design for Embedded Systems: Memory Management in RTOS. Real-Time File Systems: FAT and Real-Time File Systems (RTFS) Case Study of RTOS Implementation: MicroC/OS-II or FreeRTOS Design Example, Implementing tasks, scheduling, and interrupt handling in an RTOS.	**9**
V	**Real-Time Systems Applications and Commercial RTOS:** FreeRTOS and Linux for Real-Time Systems: FreeRTOS Architecture and Features, RT Linux and its applications, Comparison between FreeRTOS and commercial RTOS for embedded systems. Control Systems in RTOS: Adaptive Cruise Control and its RTOS implementation, Real-Time Systems in Automotive and Aerospace applications. RTOS in IoT and Networked Systems: Real-time networking (CAN, TCP/IP) for IoT applications, Synchronization and Communication in Networked Real-Time Systems.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL43G	MACHINE LEARNING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

The goal of this course is to introduce the fundamental concepts of Machine Learning and types of Machine learning algorithms.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basic concepts of Machine Learning and Python	Understand
CO2	Explain the basic concepts of various Machine Learning Algorithms	Understand
CO3	Apply Supervised and Unsupervised Machine learning algorithms using Python Programming	Apply
CO4	Apply various advanced Machine Learning Algorithms using Python Programming	Apply
CO5	Make use of machine learning algorithms for real world applications.	Apply

iii) SYLLABUS

Introduction to python and machine learning: EDA and Data Preprocessing, Data Visualization, Basics of Statistics and Types of Machine Learning Algorithms. Supervised, Unsupervised and Reinforcement learning, Classification and Regression problems; Principal Component Analysis. Advanced Techniques in Machine Learning: Ensemble Methods and Model Optimization, Applications of Machine Learning in various domains and its implementation in python.

iv) (a) TEXT BOOKS

1) McKinney, W. (2012). Python for Data Analysis. O'Reilly Media: Sebastopol.
2) Bishop C. M., "Pattern Recognition and Machine Leaming", Springer, 2010.
3) Mueller A. C. & Guido S., "Introduction to Machine Leaming with Python", O'REILLY' Publishers, 2016.
4) Geron, A. (2019). Hands-On Machine Learning with Scikit-Leam, Kerns, and TensorFlow. O'Reilly Media: Sebastopol.
5) Buduma N. & Locascio N., "Fundamentals of Deep Leaming: Designing Next-Generation Machine Intelligence Algorithms", O'REILLY' Publishers, 2017.

(b) REFERENCES

1) Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press, 2017.
2) Simon Haykin, "Neural networks and learning machines", 3rd Edition. Pearson Education India, 2010.

3) Buduma N. & Locascio N (2017), Fundamentals of Deep Learning: Designing NextGeneration Machine Intelligence Algorithm, O'REILLY' Publishers

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Python and Machine Learning:** Introduction to Python: Data Types in Python, NumPy, Pandas, Matplotlib, and Seaborn, Exploratory Data Analysis (EDA): Descriptive statistics (mean, median, variance, standard deviation), Data visualization techniques: histograms, boxplots, scatter plots. Introduction to Machine Learning and Machine Learning Algorithms (Supervised, Unsupervised and Reinforcement learning), Classification (categorical output) vs. Regression (continuous output) problems, Statistical Learning: Basics of Applied Statistics.	9
II	**Supervised Learning**: Introduction to Supervised Learning Algorithm: Linear Regression- Linear relationship, Types of correlation, Assumptions of Linear regressions, Errors and Best Fit Line, Logistic Regression: Logistic function & Sigmoid Curve, Confusion matrix - Accuracy, Precision, Recall, Specificity, Model evaluation. Classifiers: Naive Bayes Classifier, KNN Classifier and Support Vector Machine (SVM)	9
III	**Unsupervised Learning:** Introduction to Unsupervised Learning: Clustering Concept & K-Mean Clustering - Distance measures, Types of clustering: Hierarchical Clustering: Distance calculation between data points, Cluster and dendrogram formation, Cophenetic correlation. Principle Component Analysis (PCA): Principal component Covariance matrix, PCA for dimensionality reduction.	9
IV	**Advanced Techniques in Machine Learning:** Decision Tree: Decision Tree Classifier Gini Index Pruning, Ensemble Techniques: Bagging, Boosting, Random Forest. Feature Engineering and Cross-Validation: k-fold cross-validation, stratified cross-validation. Model Performance Measures & Hyperparameter tuning: Grid search, random search.	9
V	**Introduction to Deep Learning and applied Machine Learning:** Basics of Neural networks, Computer vision and Natural Language Processing. Application of Machine learning algorithms using Python: Implementing Classification and Regression Models in Python, Implementing Decision Trees and ensemble techniques in python, Deploying ML/DL Models for Real-World engineering systems (Any relevant case studies with sample datasets and tool kits)	9
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL43H	WEB PROGRAMMING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This course introduces Web Programming, covering front-end development with HTML, CSS, and JavaScript, and back-end development using Node.js with databases. Students will also explore React.js or Angular for building responsive applications, along with web deployment and basic security measures. By the end, they will gain hands-on experience in developing and deploying web applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain web architecture, HTML structure and semantic elements, and use Git and GitHub for basic version control.	Understand
CO2	Apply CSS concepts to design responsive and well-structured web pages using modern layout techniques.	Apply
CO3	Implement JavaScript to create dynamic and interactive web pages with DOM manipulation and form validation.	Apply
CO4	Develop backend-supported web applications with database integration and basic data operations.	Apply
CO5	Deploy and manage a complete web application by integrating frontend, backend and database components on suitable hosting platforms.	Create

iii) SYLLABUS

Fundamentals of web architecture, client–server model, HTML structure and semantic markup, and version control using Git and GitHub. Webpage styling using CSS including layouts with Flexbox and Grid, responsive design principles and basic animations, Dynamic webpage development using JavaScript with DOM manipulation, event handling, form validation and JSON data handling. Backend web application development using server-side programming. REST APIs and integration with frontend components. Database concepts including SQL and NoSQL basics with create, read, update and delete operations. Website deployment using static and dynamic hosting platforms with domain management, security basics and application maintenance.

iv) (a) TEXT BOOKS

1) Jon Duckett, HTML and CSS: Design and Build Websites, First Edition, Wiley, 2011.
2) Robin Nixon, Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5, Fifth Edition, O'Reilly Media, 2018.
3) Ethan Brown, Web Development with Node and Express: Leveraging the JavaScript Stack, First Edition, O'Reilly Media, 2014.

(b) REFERENCES

1) Kyle Simpson, You Don't Know JS (book series), O'Reilly Media, 2015.
2) Robert W Sebesta, Programming the World Wide Web, Pearson Education Inc, 8th Edition.
3) Eric van der Vlist, Danny Ayers, Erik Bruchez, Joe Fawcett, Alessandro Vernet, Wrox-Professional Web 2.0 Programming, Wiley-India edition.

v) COURSE PLAN

Module	Contents	No. of hours
I	Fundamentals of Web Technologies - Introduction to Web and Internet Technologies - Basics of the Internet and the World Wide Web, HTTP, HTTPS, DNS, Domain & Hosting, Difference between Static and Dynamic Websites. Tools setup: Browser DevTools, VS Code. Introduction to Git & GitHub: Git installation & configuration, Git basics: repository, commit, push, pull, clone. HTML – Structuring Web Pages - HTML Tags, Forms, Tables, Lists, Semantic Elements, Embedding Media: Images, Audio, Video, frames, HTML5 Features (Canvas, SVG, Forms, Input Types). Assignment: Create a basic static personal webpage and push to GitHub.	**10**
II	Interactive Front-End Development - UI Frameworks & Styling Introduction to Bootstrap & Tailwind CSS, Using Bootstrap Components (Navbar, Buttons, Cards), CSS Animations & Transitions. Introduction to CSS (inline, internal, external), CSS selectors, properties, units, Colors, fonts, text styling, Box model (margin, padding, border), Display, positioning, overflow, Flexbox for layout. Introduction to CSS Grid, Responsive design concepts, Media queries, Basic animations & transitions. Assignment: Styled responsive webpage (portfolio / college site)	**8**
III	Introduction to JavaScript basics - Variables, Data Types, Operators, Control Statements (Loops, Conditions), Functions, DOM Manipulation, Event Handling, Form validation using JavaScript. Working with arrays & objects. Fetch API basics (client-side data fetching). Introduction to JSON, Error handling & debugging, Git collaboration workflow (pull requests, resolving conflicts). Assignment: Dynamic webpage with form validation & interactivity.	**8**
IV	Need of Back-end. Introduction to server-side programming: Simple backend using Node.js + Express (conceptual & practical), REST API basics (GET, POST), Connecting frontend to backend. Introduction to databases (SQL vs NoSQL): Basic database operations (CRUD), Using a simple database (MySQL / MongoDB – basics), Environment variables & security basics, Git ignored files (.gitignore). Assignment: Form data stored and retrieved from database.	**7**

V	Hosting, Static vs dynamic hosting, Hosting static sites (GitHub Pages, Netlify), Hosting backend apps (Render / Railway / Vercel – concepts). Database hosting basics, Connecting hosted frontend + backend + DB, Domain names & basic DNS, HTTPS & security awareness, Versioning & release management, Basic performance & maintenance tips. Final Project: Complete full-stack web application live on the internet.	**12**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

MINORS/HONOURS

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEJ4MA/23EEJ4MC/ 23EEJ4ME/23EEJ4MG	MINIPROJECT	VAC	0	0	6	0	3	2023

i) COURSE OVERVIEW

The course encourages students to **apply the concepts, methods, and tools** learned to solve **real-world or socially relevant problems.** The course also emphasizes **innovation, and critical thinking**, encouraging students to explore new ideas and technologies. The mini project topic selected will be assigned to a group of three/four students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. It helps students develop skills in teamwork, project planning, technical documentation, and communication.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify real life engineering problems that are socially relevant, technically feasible and economically viable.	Apply
CO 2	Design proper scientific methodology to successfully complete the project	Apply
CO 3	Develop solutions to socially relevant practical problems by applying suitable scientific tools	Apply
CO 4	Evaluate the performance of the developed solution using suitable data analysis, validation techniques, and engineering judgement.	Evaluate
CO 5	Prepare a technical report and present the project outcomes effectively using appropriate engineering and communication tools	Apply
CO6	Build the culture of working effectively in a team, upholding professional and ethical responsibilities	Apply

iii) COURSE PLAN

In this course, each group consisting of maximum of four members is expected to identify a topic of interest in consultation with Faculty-in-charge of mini project, review the literature and gather information pertaining to the chosen topic, state the objectives and develop a methodology to achieve the objectives. Execute experimental procedure, design/fabrication or develop codes/programs or conduct case studies to achieve the objectives. Demonstrate the novelty of the project through the results and outcomes.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is submitted by each student at the end of the semester.

ASSESSMENT PATTERN

The final evaluation will be conducted as an internal evaluation based on the level of objectives achieved, the report and a viva-voce examination, conducted by a 3-member committee appointed by Head of the Department offering minor. The committee members shall be HoD or a senior faculty member, Mini project coordinator and project supervisor. The Committee will evaluate the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement. The progress of the mini project is evaluated through a minimum of TWO reviews. At the time of the 1st review, students are expected to propose a methodology to achieve the objectives after completing a thorough literature study of the existing systems under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution.

v) Mark Distribution

Total: 100 marks (Minimum required to pass: 50 Marks).

- Project progress evaluation by guide: 20 Marks.
- Two interim evaluations by the Evaluation Committee: 30 Marks (15 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 30 Marks
- Quality of the report evaluated by the evaluation committee: 20 Marks

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL4HA	AIRCRAFT DYNAMICS & CONTROL	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides an introduction to the fundamental principles of aircraft motion, dynamic modeling, and control system design as applied to aerospace vehicles. Students will gain theoretical insights into flight dynamics and the application of classical and modern control strategies in aviation.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the concept of aircraft configurations and the physics of flight.	Understand
CO2	Develop the equations of motion for flight.	Apply
CO3	Model the static and dynamic stability of aircraft.	Apply
CO4	Apply control theory to model and design aircraft control systems.	Apply
CO5	Summarize avionics systems relevant to flight dynamics and control.	Understand

iii) SYLLABUS

Introduction to Aircraft and Flight Mechanics: Basic flight mechanics, Aircraft structures, and components. Coordinate systems, 6 Degrees of Freedom (DoF), and generalized motion. Forces and moments on an aircraft.

Aircraft Kinematics and Equations of Motion: Rigid body kinematics and rotation sequences. Euler angles and angular velocity transformation. Newton-Euler equations of motion. 6-DOF equations for rigid aircraft. Trimmed flight and equilibrium conditions.

Static and Dynamic Stability of Aircraft: Static stability, Dynamic stability. Dynamic modes of motion. Time-domain analysis of modes. State-space formulation for stability analysis. Control surface effects on stability

Aircraft Control Systems and Feedback Principles: Control surfaces, Flight control system configurations, Classical control methods (PID, lead-lag), Stability augmentation systems (SAS), Control augmentation systems (CAS), Control design using root locus and frequency response.

Avionics and Embedded Flight Control Concepts: Basics of avionics and flight instrumentation. Flight sensors, Actuation systems, Digital control system architecture in aircraft. Fault tolerance and redundancy in flight control.

iv) (a) TEXT BOOKS:

1) John D. Anderson, Jr., *"Introduction to Flight"*, 8th Edition (or latest), McGraw-Hill Education,
2) Robert C. Nelson, *"Flight Stability and Automatic Control"*, 2nd Edition, McGraw-Hill Education, 2017.

3) Bernard Etkin & Lloyd Duff Reid, *"Dynamics of Flight: Stability and Control",* 3rd edition, Wiley, 1995.
4) Brian L. Stevens & Frank L. Lewis, *"Aircraft Control and Simulation",* 2nd edition, Wiley, 2003.
5) Cary R. Spitzer (Editor), *"Avionics: Development and Implementation",* 2nd edition, CRC Press, 2006.

(b) REFERENCES:

1) Shevell, Richard S., "*Fundamentals of Flight"*, Second Edition, Pearson Prentice-Hall, Upper Saddle River, NJ, 1989.
2) McCormick, Barnes W., "*Aerodynamics, Aeronautics and Flight Mechanics"*, Second Edition, John Wiley and Sons, Inc., Canada, 1995.
3) Small Unmanned Aircraft: Theory and Practice by Randal Beard and Timothy W. McLain.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Aircraft and Flight Mechanics:** Evolution and classification of aircraft. Basic flight mechanics: Lift, drag, thrust, and weight. Aircraft structures and components. Coordinate systems: Body, wind, and inertial axes. 6 Degrees of Freedom (DoF) and generalized motion. Forces and moments on an aircraft. Angle of attack, sideslip angle, and flight path angle.	**9**
II	**Aircraft Kinematics and Equations of Motion:** Rigid body kinematics and rotation sequences. Euler angles and angular velocity transformation. Newton-Euler equations of motion. Equation of motion of 6-DOF rigid aircraft. Small disturbance theory. Longitudinal and lateral-directional dynamic model (Equations only). Trimmed flight and equilibrium conditions.	**9**
III	**Static and Dynamic Stability of Aircraft:** Static stability: longitudinal, lateral, and directional. Dynamic stability: stability derivatives and criteria. Dynamic modes of motion: State space representation: Short-period and phugoid, Dutch roll, spiral, roll subsidence (Concepts and basic equations only). Time-domain analysis of modes. State-space formulation for stability analysis. Control surface effects on stability. Simulation of simple aircraft model time domain analysis.	**9**
IV	**Aircraft Control Systems and Feedback Principles:** Overview of aircraft control systems. Control surfaces: elevator, rudder, aileron. Flight control system configurations: manual, automatic.	**9**

	Introduction to classical control methods (PID, lead-lag concept only), Stability augmentation systems (SAS), Control design using root locus and frequency response. MATLAB Simulation.	
V	**Avionics and Embedded Flight Control Concepts:** Basics of avionics and flight instrumentation. Flight sensors: gyroscopes, accelerometers, IMUs, pitot tubes. Actuation systems: servos, fly-by-wire systems. Introduction to Integrated Modular Avionics, Avionics buses: ARINC 429, MIL-STD-1553. Digital control system architecture in aircraft. Overview of certification standards: DO-178C, DO-254, DO 160, SAE ARP 4761, and ARP 4754. Fault tolerance and redundancy in flight control.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL4HC	DEEP LEARNING	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Demonstrate basic concepts in machine learning.	Understand
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	Understand
CO3	Demonstrate the concept of the feed forward neural network and its training process.	Understand
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	Apply
CO5	Use different neural network/deep learning models for practical applications.	Apply

iii) SYLLABUS

Introduction to deep learning, Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Overfitting, underfitting, hyper parameter tuning. Neural Networks. Gradient Descent solution for Perceptron, Multilayer perceptron. Introduction to optimization linear least squares. Stochastic gradient descent, Building ML algorithms and challenges. Convolutional Neural Networks. Practical challenges of common deep learning architectures. Case study-pretrained models. Recurrent neural networks, recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Applications - computer vision, speech recognition, natural language processing. Research Areas - auto encoders, representation learning, boltzmann machines, deep belief networks.

iv) (a) TEXT BOOKS

1) Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2) Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3) Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

(b) REFERENCES

1) Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J Marksll, A Bradford Book,2014
2) Practical Convolutional Neural Networks by MohitSewak, Md.Rezaul Karim, Pradeep Pujari, Packt Publishing 2018
3) Hands-On Deep Learning Algorithms with Python bySudharsan Ravichandran, Packt Publishing 2019
4) Deep Learning with Python by Francois Chollet, Manning Publications Co.,2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Deep Learning and Neural Networks, Perceptron, Activation Functions, and Backpropagation, Gradient Descent and Optimization Algorithms (SGD, Adam, RMSprop). Loss Functions and Regularization Techniques. Introduction to TensorFlow & PyTorch. Hyperparameter Tuning, Weight Initialization, and Batch Normalization. Hands-on Case study: Building a simple Feedforward Neural Network	**9**
II	**Computer Vision - Convolutional Neural Networks (CNNs)** Working with Images: Digitization, Sampling, and Quantization, Convolutional Neural Networks (CNN) - Architecture and Layers, Pooling Layers, Dropout, and Data Augmentation. Case Studies: LeNet, AlexNet, VGGNet, ResNet, and MobileNet, Transfer Learning and Fine-tuning Pretrained Models. Object Detection: Region Proposals, YOLO, SSD, Image Segmentation: U-Net, Mask R-CNN, Semantic vs. Instance Segmentation. Hands-on Case study: Image Classification & Object Detection using CNNs	**10**
III	**Advanced Computer Vision & Generative Models** Feature Extraction & Transfer Learning Applications, Siamese Networks for Image Similarity and Metric Learning, Generative Adversarial Networks (GANs) - Concepts and Training, Variational Autoencoders (VAEs) for Image Generation. Hands-on Case Study: GAN Implementation and Style Transfer.	**8**

IV	**Natural Language Processing (NLP) -** Introduction to NLP and Text Preprocessing, Tokenization, Lemmatization, Stemming, Stop-word Removal. Word Embeddings: Word2Vec, GloVe, FastText. Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM): Bidirectional LSTMs and GRUs, Sentiment Analysis. Named Entity Recognition (NER), Part-of-Speech (POS) Tagging. Hands-on: Implementing Word Embeddings and LSTM-based Sentiment Analysis.	**9**
V	**Advanced NLP - Transformers and Large Language Models** Introduction to Attention Mechanisms & Self-Attention, Transformers and BERT (Bidirectional Encoder Representations from Transformers), GPT (Generative Pre-trained Transformer) Models, Neural Machine Translation and Sequence-to-Sequence Models, Speech Recognition and Text-to-Speech Models. Applications: Chatbots, Text Summarization, and Question Answering Systems. Hands-on: Implementing BERT for Text Classification.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL4HE	OPERATION AND CONTROL OF AC/DC SMART GRIDS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces the fundamentals of Smart Grids and Microgrids, focusing on modern power system architecture and operation. It covers energy storage systems, DC and AC microgrids, protection, and control strategies. Students learn about hybrid AC–DC networks, load flow analysis, and smart grid planning techniques.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the concepts, architecture, and key technologies involved in Smart Grid systems, including energy storage and communication infrastructure.	Understand
CO2	Apply appropriate monitoring and protection techniques for Smart Grids.	Apply
CO3	Develop the modeling, operation, and control strategies of DC Microgrids	Apply
CO4	Explain the operation and hierarchical control of AC Microgrids and perform load flow analysis for AC–DC hybrid distribution networks.	Understand
CO5	Summarize the smart grid planning strategies including demand response, energy management, V2G concepts	Understand

iii) SYLLABUS

Review of Smart Grid, Smart Grid Architecture- Components and Architecture of Smart Grid Design, Introduction to energy storage devices, Different types of energy storage technologies, Monitoring and Protection of Smart Grids, DC Microgrid Topologies, DC Microgrid Protection Devices, Applications of DC, Challenges in DC Microgrid, Overview of AC Microgrid controls, AC-DC Distribution Network., Structure of AC-DC distribution network, Classifications of buses, Overview of Load-Flow analysis, Planning aspects of smart grid, Demand side management- Demand response, Energy management, Planning of smart grid systems, Simulation and Case study.

iv) (a) TEXT BOOKS

1) Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-47062761-7, Wiley
2) James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0-470-889398, Wiley
3) R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill
4) Chris Mi, M. Abul Masrur, David Wenzhong Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, 2011, Wiley publication.

(b) REFERENCES

1) Danda B. Rawat; Chandra Bajracharya, "Cyber security for smart grid systems: Status, challenges and perspectives", IEEE Southeast Con 2015, DOI: 10.1109/SECON.2015.7132891.
2) Pillitteri, V. and Brewer, T. (2014), "Guidelines for Smart Grid Cyber security", NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], https://doi.org/10.6028/NIST.IR.7628r1.
3) G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 2nd Edition.
4) MOOC Course: Smart Grid: Basics to Advanced Technologies https://onlinecourses.nptel.ac.in/noc26_ee84/

v) COURSE PLAN

Module	Contents	No. of hours
I	**Review on Smart Grid** - Environmental impact and Climate Change, Economic Issues- DG and ESS **Smart Grid Architecture:** Components and Architecture of Smart Grid, Overview of technologies used in Smart Grid, Fundamental components of Smart Grid – Transmission Automation –Distribution Automation –Renewable Integration, Advanced metering infrastructure, Communication Technologies **Energy Storage:** Introduction to energy storage devices, Different types of energy storage technologies, Analytical modelling of energy storage devices, Optimal sizing and siting of storages. Battery management system (BMS).	10
II	**Monitoring and Protection:** Intelligent Electronic Devices (IED) and their application for monitoring & protection, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU). Islanding detection techniques, Smart grid protection- Adaptive protection scheme- Different types of relays.	9
III	**Modelling of DC Smart Grid Components:** DC Microgrid Topologies, Key Energy Sources, Types of Loads, Switch Mode Power Converters (Buck Boost and Fly back), DC Microgrid Communication, DC Microgrid Protection Devices, Challenges in DC Microgrid. **Control of DC Microgrid**: Types of control - Decentralized control, Distributed control, Centralized control.	9
IV	**Operation and control of AC Microgrid:** Introduction- voltage level and Architecture, Need for Microgrid Control, Hierarchical Controls, Intelligent Control Techniques, Overview of AC Microgrid controls. **System Analysis of AC/DC Smart Grid:** AC-DC Distribution Network., Structure of AC-DC distribution network, Classifications of	9

	buses, Overview of Load-Flow analysis, AC-DC Load-Flow analysis, Backward Sweep algorithm, Power converter modelling, Distributed Generations modelling, Basic Steps for Load Flow Formulation of AC-DC Distribution Network.	
V	**Smart Grid Planning**: Planning aspects of smart grid, Demand side management- Demand response, Demand Response Analysis of Smart Grid, Energy management, Planning of smart grid systems, energy market and V2G **Simulation and Case study:** AC Microgrid, DC Microgrid, AC-DC Hybrid Microgrid	8
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

SYLLABUS

SEMESTER VIII

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23HSL00A	Management for Engineers	HSC	3	0	0	0	3	2023

i. COURSE OVERVIEW

The objective of the course is to introduce the basic concepts and functions of management, highlight its role in organizational performance, and explore decision-making approaches that help managers achieve excellence.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the characteristics of management in the contemporary context.	Understand
CO 2	Summarize the functions of management.	Understand
CO 3	Apply the concepts of decision-making models and productivity measurement to enhance organizational effectiveness.	Apply
CO 4	Apply the project management techniques to determine project schedules and completion probabilities.	Apply
CO 5	Explain the functional areas of management and the concept of entrepreneurship.	Understand

iii. SYLLABUS:

Introduction to management theory - Characteristics of Management, Introduction to management theory, System approaches to Management, Levels of Manager and Skill required.

Management and organization - Functions of Management, Planning types, Principles of organisation, Organisation Structures. Staffing, Leading and Controlling.

Productivity and decision making - Concept of productivity and its measurement. Decision making process, Decision trees;

Project management- Network construction, CPM and PERT
Networks, Scheduling computations, PERT time estimates, Probability of completion of project.

Functional areas of management- Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility.

iv (a) TEXT BOOKS

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 10th ed., McGraw-Hill, 2015
2. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 15th ed., Pearson, 2016.
3. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 11th ed., McGraw-Hill Education, 2020.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2020.

(b) REFERENCES

1. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 15th ed. McGraw Hill Education (India), 2018.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 5th edition, 2012
3. K. Ashwathappa, 'Human Resources and Personnel Management', TMH, 7th edition, 2011.
4. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 2019

v. COURSE PLAN

Module	Contents	Hours
I	Management Definition, Characteristics of Management, Importance of Management, Management - Art or Science perspective, Evolution of Management - Introduction to Management Theories-Taylor's Scientific Management, Gilbreth's Motion Study, McGregor's Theory X and Theory Y, System Approach and Contingency Approach to Management, Henry Mintzberg's Managerial Roles, Levels of Management – Top, Middle, and Operational, Skills Required for Managers – Technical, Human, and Conceptual skills.	**8**
II	Functions of Management - Planning, Organizing, Staffing, Leading, Controlling. Planning- Planning types- strategic, tactical and operational plans, Mission, Goals, Strategy, Programmes, Procedures, Steps in Planning. Organising- Principles of Organisation, Delegation, Span of Control, Organisation Structures. Staffing- Selection process and employee training, Employee retention- Maslow's Hierarchy of Needs. Directing and Leadership -Traits of a leader, Leader vs Manager, Managerial grid model for leadership styles. Controlling-Types of control: Preventive, Concurrent, and Feedback.	**8**

III	Concept of productivity and its measurement; Competitiveness- Cost Advantage and Differential advantage, Quality, Speed, Innovation. Decision making process; Steps, types - Programmed and Non-Programmed decisions. Decision making under uncertainty- Maximum Criterion, Minimax Criterion, Maximin Criterion, Laplace Criterion, Hurwicz Alpha Criterion, Decision making under risk – Expected Monetary Value, Expected Opportunity Loss, Decision trees.	**10**
IV	Project Management, Network construction, Arrow diagram, CPM and PERT to find critical paths, Critical Path Method -Determining Start and Finish Times: Earliest Start Time (ES), Earliest Finish Time (EF), Latest Start Time (LS), Latest Finish Time (LF), Float. Project Evaluation Review Technique PERT, PERT Time Estimates – Optimistic, Pessimistic, and Most Likely Time Calculations, Probability of completion of project.	**10**
V	Introduction to functional areas of management, Operations management, Human resources management, Marketing management, financial management, Entrepreneurship-Characteristics and mindset of successful entrepreneurs Types of entrepreneurships- Small Business Entrepreneurship, Scalable Start up Entrepreneurship, Social Entrepreneurship, Corporate social responsibility.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELJ48B	PROJECT	PWS	0	0	10	0	5	2023

i) COURSE OVERVIEW:

The aim of this course is to apply engineering knowledge in solving practical problems, to foster innovation in design of products, processes or systems, and to develop creative thinking in finding viable solutions to engineering problems. The course is mainly intended to evoke the innovation and invention skills of a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation.

Desirable: The project outcome should be published in a peer-reviewed journal or presented at a conference, or a patent application should be filed.

It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Apply multidisciplinary knowledge to model and solve real world problems.	Apply
CO 2	Apply innovative and creative problem-solving to develop sustainable and socially relevant products, processes, or technologies.	Create
CO 3	Exhibit effective teamwork and leadership skills in diverse environments, with the ability to comprehend and carry out designated responsibilities.	Apply
CO 4	Execute tasks by planning effectively and utilizing available resources to meet deadlines, while adhering to ethical and professional standards.	Apply
CO 5	Effectively document, present, and communicate technical and scientific outcomes in professional written and verbal formats.	Apply

iii) Evaluation Guidelines

Total: 100 marks (Minimum required to pass: **50** Marks).

● Project progress evaluation by guide: **20** Marks.

● Two interim evaluations by the Evaluation Committee: **30** Marks (15 marks for each evaluation).

● Final evaluation by the Final Evaluation committee: **30** Marks

● Quality of the report evaluated by the evaluation committee: **20** Marks

Interim Evaluation:

The Evaluation committee comprises of HoD or a senior faculty member, Project coordinator and Project supervisor.

Final Evaluation:

The final evaluation committee comprises of Project coordinator, domain expert from the Department and expert from Industry/research/academic Institute / senior faculty from a sister department.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELI48A	INTERNSHIP	PWS	0	0	-	0	5	2023

i) COURSE OBJECTIVES

The internship is an integral component of the undergraduate programme aimed at providing students with immersive learning through practical exposure in industry, research organizations, or academic institutions.

BENEFITS OF INTERNSHIP

Benefits to Students

- Provides practical exposure to real-world industrial and organizational environments, enabling the application of theoretical knowledge gained in classrooms.
- Enhances professional competencies such as communication, teamwork, time management, interpersonal skills, and workplace ethics.
- Facilitates the development of technical and domain-specific skills, thereby strengthening overall professional readiness.
- Assists students in assessing their career interests and determining the suitability of a particular industry or profession.
- Improves employability by strengthening profiles for placements, higher education, and potential recruitment by the host organization.
- Encourages professional networking and relationship - building with industry experts and peers.
- Offers an opportunity to evaluate the organization and work culture before committing to full-time employment.

Benefits to the Institute

- Strengthens industry - academia collaboration.
- Facilitates smoother and more effective placement processes.
- Enhances institutional credibility and brand value.
- Supports student engagement and retention.
- Enables curriculum updates based on industry and student feedback.
- Improves the overall teaching - learning process through industry relevance.

Benefits to the Industry

- Provides access to a pool of motivated, job-ready students who can contribute immediately.
- Offers a cost-effective mechanism to evaluate and recruit potential employees.
- Enables the availability of a flexible workforce for temporary, project-based, or seasonal requirements.
- Brings fresh perspectives and innovative approaches to problem-solving.
- Enhances organizational visibility and employer branding within academic institutions.
- Strengthens corporate image by contributing to education and skill development.

TYPES OF INTERNSHIPS

- Industry Internship with/without Stipend
- Government / PSU Internship (BARC/Railway/ISRO etc.)
- Internship with prominent education/ Research Institutes
- Internship with Incubation centres /Start-ups

ii) COURSE OVERVIEW

Students can undertake an internship at an industry, research organization, or a reputed academic institution with prior approval of the respective Head of the Department.

The internship is designed to promote meaningful skill development through structured, outcome-driven experiential learning. It shall focus on clearly defined technical competencies, such as domain-specific skills, software proficiency, exposure to industry-standard tools, and structured engineering problem-solving tasks. The learning objectives of the internship, along with the expectations of the host organization and the academic requirements of the institution, shall be clearly defined in consultation with the host organization and mutually agreed upon prior to the approval of the internship.

Each student shall be assigned a faculty guide/supervisor for monitoring and evaluation. The internship shall be relevant to the student's stream of study and can be carried out in Semester **VII** or Semester **VIII**, as specified by the Department, for a minimum duration of **three months.**

A student shall be permitted to undertake the internship only after the respective semester registration. During the internship period, any other courses or academic activities shall be pursued in online mode or as specified by the Department, to ensure timely fulfillment of all academic requirements.

iii)COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply theoretical knowledge and engineering principles to practical problems encountered in professional practice.	Apply
CO2	Demonstrate technical competence and understanding of tools, techniques, and processes relevant to the chosen field of specialization.	Apply
CO3	Analyse social, environmental, economic, safety, and administrative factors influencing industrial operations and decision-making processes.	Analyze
CO4	Communicate effectively through technical reports, presentations, and professional interactions in an industrial or research environment.	Apply
CO5	Apply professional ethics, teamwork, and adaptability while performing assigned tasks in a multidisciplinary work setting.	Apply

iv) GUIDELINES FOR STUDENTS

- Duration of internship is three to six months (One semester).
- Students may undertake mini projects, case studies, or related technical tasks during the internship with the prior approval of the competent authority at the host organisation.
- Students shall strictly adhere to the rules, regulations, code of conduct, and working hours prescribed by the host organisation.

- Prior permission shall be obtained from the host organisation before using or reproducing any data, documents, drawings, photographs, or proprietary information for academic purposes.
- Students shall follow all ethical practices, confidentiality requirements, and Standard Operating Procedures (SOPs) of the host organisation.
- Students shall comply with all health, safety, and environmental guidelines prescribed by the host organisation during the internship period.
- Students shall maintain regular contact with the assigned faculty guide/supervisor and submit weekly progress updates on the work carried out.
- Each student shall maintain a diary/logbook recording daily activities, learning outcomes, and progress throughout the internship period.
- On completion of the internship, students shall submit the following documents to the Department:
  - ✓ Internship report detailing the work carried out and learning outcomes
  - ✓ Internship Completion Certificate issued by the host organisation
  - ✓ Feedback from the employer
  - ✓ Proof of stipend received, if applicable

v) ASSESSMENT PATTERN

The marks awarded for the Internship will be based on the following:

(i) Evaluation done by the industry,
(ii) Student's diary,
(iii) Internship report, and
(iv) Internship viva voce.

Continuous Assessment		
Student's diary/ Daily Log	:	25 marks
Evaluation done by the industry	:	25 marks
Total Continuous Assessment	:	**50 marks**
Final Assessment		
Internship Report	:	25 Marks
Internship Viva Voce	:	25 marks
Total Final Assessment	:	**50 marks**
TOTAL	:	**100 marks**

Student's Diary/ Daily Log

The purpose of maintaining a daily diary is to cultivate systematic documentation habits and to encourage students to record observations, impressions, information gathered and suggestions, if any, during the internship period. The diary shall contain a day-to-day record of activities, learning experiences, technical details, and relevant sketches or drawings related to

the work carried out. The daily diary shall be signed regularly by the industry supervisor and shall be verified and ratified by the faculty guide during the interim review.

The interim review shall be conducted midway through the internship by the Internship Review Committee, comprising the internship coordinator, faculty supervisor, and a senior faculty member of the Department. The review may be conducted in online or offline mode, based on the feasibility of the student's physical presence on campus.

Internship Report

On completion of the internship, each student shall prepare and submit a comprehensive internship report to the faculty supervisor. The report shall present a systematic account of the activities undertaken, observations made and knowledge gained during the training period. Students may consult the industry supervisor during the preparation of the final report, subject to compliance with the confidentiality policies and norms of the host organisation. The completed report shall be duly certified and signed by the Industry Supervisor, Faculty guide and the Head of the Department.

The internship report shall be evaluated based on the following criteria:

- Originality and technical content
- Adequacy, clarity and relevance of the written presentation
- Organization, format, use of drawings, sketches, language and overall style
- Variety and relevance of learning experiences documented
- Demonstration of practical applications and linkage with theoretical concepts covered in the curriculum

Evaluation done by the industry

The performance of the student during the internship shall be evaluated by the industry supervisor or the person-in-charge using a prescribed evaluation format provided by the institution. The evaluation shall cover key parameters such as professional behaviour, technical competence, learning ability, initiative, quality of work, communication skills, teamwork, discipline, time management, and overall professional attitude.

The faculty guide shall share the evaluation format with the host organization and coordinate the assessment process. The completed evaluation form shall be duly signed and sealed by the industry supervisor and submitted to the Department as part of the internship assessment records.

Internship Viva Voce

The viva voce examination shall be conducted by the Internship Review Committee. The committee shall assess the student's understanding of the internship work, technical competence, learning outcomes, and professional orientation.

PROGRAMME ELECTIVE IV

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44A	COMPUTER AIDED DESIGN OF ELECTRICAL MACHINE	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This course introduces the principles and methodologies of Computer-Aided Design (CAD) of electrical machines. It emphasizes design formulation, modeling, and performance evaluation using computational and simulation-based approaches. The course bridges classical electrical machine design concepts with modern CAD and finite-element-based analysis techniques. The use of CAD and FEM tools in this course is limited to conceptual understanding and demonstration-level exposure, enabling students to analyze machine behavior without requiring detailed software training.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the role of computer-aided design approaches, design workflows, and optimization concepts in the design of electrical machines.	Understand
CO2	Explain the fundamental design considerations of electrical machines including magnetic circuits, materials, losses, efficiency, and thermal aspects.	Understand
CO3	Interpret the mathematical modeling and computational techniques, including finite element method concepts, used in the analysis of electrical machines.	Understand
CO4	Apply the computer-aided design concepts and do the performance evaluation of transformers and rotating electrical machines.	Apply
CO5	Apply the design concepts and performance characteristics of special electrical machines using computer-aided and simulation-based approaches.	Apply

iii) SYLLABUS

Introduction to computer-aided design in electrical machine design, design workflow, formulation of design problems, constraints, and basic optimization concepts.

Fundamentals of electrical machine design including magnetic circuits, electrical and magnetic loading, materials, losses, efficiency, and thermal considerations.

Mathematical modeling and computational methods for electrical machines, introduction to numerical techniques and finite element method, meshing, boundary conditions, and interpretation of simulation results.

Computer-aided design and performance evaluation of transformers and conventional rotating electrical machines such as DC, induction, and synchronous machines.

Design concepts and CAD-based analysis of special electrical machines including permanent magnet machines, brushless DC motors, switched reluctance machines, synchronous reluctance machines, and an overview of axial flux machines.

iv) (a) TEXT BOOKS

1) A. K. Sawhney and A. Chakrabarti, A Course in Electrical Machine Design, Dhanpat Rai & Co. (P) Limited, New Delhi, 2017.
2) Albert E Clayton & Hancock N.N., Performance and Design of DC Machines, Oxford and IBH Publishing Co. & Pvt. Ltd, New Delhi, 3 rd Edition, 1971.
3) M. G. Say, Theory and Design of Electrical Machines, CBS Publishers, 2016.

(b) REFERENCES

1) Ion Boldea, Reluctance Electric Machines: Design and Control, CRC Press, 2018.
2) S. J. Salon, Finite Element Analysis of Electrical Machines, Springer, 2018.
3) P. C. Sen, Principles of Electrical Machines and Power Electronics, Wiley, 2014.
4) FEMM / Ansys Maxwell / JMAG Software Documentation and Tutorials.
5) Deshpande M.V., Design and Testing of Electrical Machines, PHI Learning Pvt. Ltd., 2010.
6) Juha Pyrhonen, Valeria Hrabovcova, Tapani Jokinen, Design of Rotating Electrical Machines, John Wiley and Sons Inc., 2nd Edition 2013.
7) Say M.G., The Performance and Design of AC Machines, CBS Publishers, New
8) Delhi, 3rd Edition, 2002.
9) Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press, 2nd Edition, January 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Computer Aided Design of Electrical Machines** Conventional versus computer-aided machine design approach, design process and flowcharts, problem formulation in machine design, design variables, constraints and objective functions, basic optimization concepts, overview of CAD and CAE tools used in electrical machine design.	**8**
II	**Fundamentals of Electrical Machine Design** Magnetic circuit design, electrical and magnetic loading, selection of core, conductor and insulation materials, losses and efficiency considerations, thermal aspects and cooling methods, introduction to equivalent-circuit-based design concepts.	**9**
III	**Computational Methods and Finite Element Analysis** Introduction to numerical methods in electromagnetic field analysis, mathematical modelling of electrical machines, fundamentals of finite element method (FEM), discretization and meshing concepts, boundary conditions, pre-processing and post-processing stages, interpretation of FEM-based simulation results. Simulation using ANSYS (Demo or assignment-based tasks).	**9**
IV	**Computer Aided Design of Conventional Electrical Machines** Computer-aided design and analysis of transformers, DC machines,	**10**

	induction machines and synchronous machines, parametric modelling of machine components, performance evaluation using CAD-based methods.	
V	**Computer Aided Design of Special Electrical Machines** Design concepts of permanent magnet synchronous machines and brushless DC motors, introduction to switched reluctance and synchronous reluctance machines, overview of axial flux machines, comparative performance analysis of special machines using CAD-based approaches.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44B	SMART GRID TECHNOLOGIES	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course introduces various advancements in the area of smart grid. It also introduces distributed energy resources and micro-grid. In addition to this, cloud computing, cyber security and power quality issues in smart grids are also introduced.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Outline the basic concept of distributed energy resources, micro-grid and smart grid.	Understand
CO2	Choose appropriate Information and Communication Technology (ICT) in a smart grid.	Apply
CO3	Explain infrastructure and technologies for the consumer domain of smart grid.	Understand
CO4	Explain infrastructure and technologies for smart substation and distribution automation.	Understand
CO5	Develop cloud computing infrastructure for smart grid considering cyber security.	Apply
CO6	Identify power quality issues in smart grid context.	Apply

iii) SYLLABUS

Introduction to smart grid: Evolution, definition, need, function, opportunities, barriers, components and architecture.

Information and Communication Technology in Smart Grid: Wired and wireless communication, Communication Protocols in Smart grid, Introduction to IEC 61850 standard and benefits.

Introduction to smart meters, Electricity tariff, Real Time Pricing, Plug in Hybrid Electric Vehicles, Intelligent Electronic Devices and their application for monitoring & protection.

Smart substations, Substation automation, Feeder automation, Fault detection, Isolation, and Service Restoration. Introduction to Smart distributed energy resources and their grid integration, Smart inverters. Energy Management.

Cloud Computing in Smart Grid: Private, Public and hybrid cloud. Types of cloud computing services. Cloud architecture for smart grid, Cyber Security: Challenges and solution in smart grid.

Power Quality Management in Smart Grid: Power quality and Electromagnetic compatibility.

iv) (a) TEXT BOOKS

1) Stuart Borlase, *Smart Grid Infrastructure Technology and Solutions*, CRC Press; 2nd Edition, 2017.
2) James Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Wiley, 2012.
3) S. Chowdhury, Microgrids and Active Distribution Networks, *Institution of Engineering and Technology*, 2009.
4) Chris Mi, M. Abul Masrur, David Wenzhong Gao, *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*, 2011, Wiley publication.

(b) REFERENCES

1) Danda B. Rawat; Chandra Bajracharya, Cyber security for smart grid systems: Status, challenges and perspectives, *IEEE Southeast* Con 2015, DOI: 10.1109/SECON.2015.7132891.
2) Pillitteri, V. and Brewer, T. (2014), *Guidelines for Smart Grid Cyber security*, NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], https://doi.org/10.6028/NIST.IR.7628r1.
3) Barker, Preston, Price, Rudy F., *Cyber security for the Electric Smart Grid: Elements and Considerations*, Nova Science Publishers Inc, 2012.
4) Eric D. Knapp, Raj Samani, *Applied Cyber Security and the Smart Grid: Implementing Security Controls into the Modern Power Infrastructure*, Syngress; 1st Edition, 2013.
5) Richard J. Campbell, *The Smart Grid and Cyber security: Regulatory Policy and Issues*, Congressional Research Service, 2011.
6) Dariusz Kloza, Vagelis Papakonstantinou, Sanjay Goel, Yuan Hong, *Smart grid security*, Springer, 2015.
7) Roger C. Dugan, *Electrical Power Systems Quality*, McGraw-Hill Publication, 3rd Edition, 2012.
8) G.T. Heydt, *Electric Power Quality*, Stars in a Circle Publications, 2nd Edition, 2000.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Smart Grid**: Definitions, Need, Functions, Opportunities and Barriers of Smart Grid, Difference between Conventional Grid and Smart Grid, Concept of Resilient and Self-Healing Grid. Components and Architecture, Inter-Operability, Impacts of Smart Grid. Present Development and International Policies in Smart Grid, Smart Grid Standards.	**9**
II	**Information and Communication Technology in Smart Grid**: Wired and Wireless Communication - Radio Mesh, ZIGBEE, 3G, 4G and 5G, Digital PLC, DSL, Wi-Max, LAN, NAN, HAN, Wi-Fi, Bluetooth. Bluetooth Low Energy (BLE), Light-Fi, Substation Event - GOOSE.	**9**

	Communication Protocols in Smart Grid, Introduction to IEC 61850 Standard and Benefits, IEC Generic Object-Oriented Substation Event - GOOSE. IEC 61850, Substation Model.	
III	**Smart Grid Technologies Part I:** Introduction to Smart Meters, Electricity Tariff, Real Time Pricing- Automatic Meter Reading (AMR) System, Advanced Metering Infrastructure (AMI). Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Grid to Vehicle. Smart Sensors, Smart Energy Efficient End Use Devices, Home & Building Automation, Intelligent Electronic Devices (IED) and their Application for Monitoring and Protection, Phasor Measurement Unit (PMU), Standard for PMU. Time Synchronization Techniques, Wide Area Monitoring, Control and Protection Systems – Need, Components and Architecture of WAMS.	**9**
IV	**Smart Grid Technologies Part II:** Smart Substations, Substation Automation, Feeder Automation, Fault Detection, Isolation, and Service Restoration, Geographic Information System (GIS), Outage Management System (OMS). Introduction to Smart Distributed Energy Resources and their Grid Integration, Smart Inverters. Concepts of Energy Management, Demand Response- Demand Side Management, Demand Side Ancillary Services, Dynamic Line Rating.	**9**
V	**Cloud Computing in Smart Grid**: Public and Hybrid Cloud, Cloud Architecture of Smart Grid, Types of Cloud Computing Services- IaaS, SaaS, PaaS, DaaS. **Cyber Security -** Cyber Security Challenges and Solutions in Smart Grid**, C**yber Security Risk Assessment, and Security Index Computation. **Power Quality Management in Smart Grid -** Fundamentals, Power Quality & EMC in Smart Grid.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44C	HVDC AND FACTS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces the fundamentals of HVDC transmission and FACTS technologies. It covers comparison of AC and DC transmission systems, applications, planning aspects, and modern trends in HVDC. Basic FACTS concepts, objectives, classification, benefits, and applications are discussed. The course explains the operation and analysis of HVDC converters, including rectifier and inverter characteristics. Basic HVDC control strategies are introduced to understand system operation. The course also covers static shunt and series compensation, focusing on the types, working principles, and applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basic concepts related to HVDC transmission and FACTS devices	Understand
CO2	Illustrate the working of Graetz circuit in HVDC transmission	Understand
CO3	Explain various HVDC control schemes	Understand
CO4	Summarize the operation of various Static Shunt Compensators	Understand
CO5	Summarize the operation of various Static Series Compensators	Understand

iii) SYLLABUS

BASIC HVDC CONCEPTS: Comparison of AC-DC transmission systems, application of DC transmission, types of DC links, Benefits from FACTS controllers.

HVDC CONVERTERS: Graetz circuit.

HVDC SYSTEM CONTROL: Basic control-desired features of control-actual control Characteristics.

STATIC SHUNT COMPENSATION: Objectives of Shunt Compensation, Working of various Static Shunt Compensators.

STATIC SERIES COMPENSATORS: Concept of series capacitive compensation, GCSC, TSSC and TCSC.

vi) (a) TEXT BOOKS

1) K. R. Padiyar, “HVDC Transmission Systems”, 2nd edition, New Age International publishers, 2012.

2) N. G. Hingorani and L. Gyugui, “Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems”, B.S. Publications, Indian Reprint 2000.

(b) REFERENCES

1) E. Uhlmann, “Power Transmission by Direct Current”, Springer 1st edition, 2012.

2) Vijay K. Sood, “HVDC and FACTS Controller: Application of Static Converters in power systems”, IEEE Power Electronics and Power Systems series, Kluwer Academic publishers, Boston, First edition January 2004.

3) E.W. Kimbark, "Direct Current Transmission", Wiley Inter Science-NewYork, 1971.
4) R. Mohan Mathur, Rajiv K Varma, "Thyristor based FACTS Controller for Electrical Power Systems", John Wiley Sons, 2011.
5) X. P. Zhang, C. Rehtanz, B.Pal, "Flexible AC Transmission System Modeling and Control", Springer, 2006.
6) Padiyar K.R., 'FACTS controllers for Transmission and Distribution Systems' New Age International Publishers, 1st Edition, 2007.
7) Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 1st Edition, 2002.

v) COURSE PLAN

Module	Contents	No. of hours
I	**BASIC HVDC CONCEPTS**: Introduction, Comparison of AC and DC Transmission (Economics of power transmission, Technical performance and Reliability), Application of DC transmission, Description of DC transmission system (Types of DC links and Converter Station), Planning for HVDC transmission, Modern trends in HVDC technology. **FACTS CONCEPTS:** Definition and evolution of FACTS, objectives of FACTS controllers. Classification of FACTS Controllers-shunt, series, and combined shunt–series controllers with suitable examples (conceptual understanding only), Benefits and Applications of FACTS.	**9**
II	**HVDC CONVERTERS:** Introduction, Graetz circuit –with grid control but no overlap-with grid control and overlap less than 60^0 - relationship between AC and DC quantities-equivalent circuit of rectifier, Inversion-equation of average direct current and voltage in terms of β and γ– equivalent circuit of inverter.	**9**
III	**HVDC SYSTEM CONTROL:** Basic means of control-desired features of control-actual control characteristics-constant minimum ignition angle control-constant current control-constant extinction angle control-tap changer control-power control and current limits, System control hierarchy, firing angle control.	**9**
IV	**STATIC SHUNT COMPENSATION:** Introduction to shunt compensation and its role in reactive power control. Types of static shunt compensators – Static VAR Compensator (SVC) and STATCOM. Working principle of SVC using thyristor-controlled reactors and capacitors. Working principle of STATCOM based on voltage source converters. Comparison of SVC and STATCOM in terms of response and performance. Applications of static shunt compensators in power systems.	**9**

V	**STATIC SERIES COMPENSATION:** Concept of series capacitive compensation, Types of static series compensators – GCSC, TSSC and TCSC. Working principle of GCSC. Working principle of TSSC and TCSC for controllable series reactance. Comparison of series compensators based on controllability and response. Applications of static series compensators in improving power transfer capability and system stability.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

ourse Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44D	DIGITAL IMAGE PROCESSING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course is designed impart the knowledge of image fundamentals and the mathematical transformations essential for various image-processing operations. It introduces students to key techniques such as image segmentation, image enhancement, and image compression.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the various aspects of digital image representation.	Understand
CO2	Apply matrix theory and mathematical transforms for image processing.	Apply
CO3	Interpret various image segmentation techniques and morphological operations.	Understand
CO4	Apply the image enhancement techniques in spatial and frequency domain	Apply
CO5	Explain the techniques for compression and restoration of images.	Understand

iii) SYLLABUS

Digital Image Fundamentals: Image Representation- simple image formation model. Color image fundamentals- 2D sampling, quantization. Review of matrix theory - Toelpitz, Circulant and Block matrix. Review of Fourier transform and DFT – FFT. Image segmentation: Segmentation and threshold function, Matching, Colour segmentation. Morphological operations, Image Enhancement in Spatial domain: Basic Grey level transforms, Histogram, Histogram processing: Smoothening and sharpening filters, Laplacian Filters. Image Enhancement in Frequency domain. Image compression: Need for image compression, Basics of image compression standards- JPEG, MPEG. Image restoration- Blind image Restoration. MATLAB implementation

iv) (a) TEXT BOOKS

1) Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, 4th edition, Pearson Education India, 2019.
2) S Jayaraman, S Esakkirajan, T Veerakumar, “Digital image processing” ,5th edition, Tata Mc Graw Hill, 2015.
3) S. Jayaraman, S. Esakkirajan, T. Veerakumar, Tata McGraw Hill 2014.
4) Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, 1st edition, PHI Learning Pvt. Ltd., 2011.

(b) REFERENCES

1) Anil Jain K, "Fundamentals of Digital Image Processing", 3rd edition, PHI Learning Pvt. Ltd., 2011.
2) Kenneth R Castleman, "Digital Image Processing", 2nd edition, Pearson Education, 2003.
3) Pratt William K, "Digital Image Processing", 4th edition, John Wiley Publications, 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Digital Image Fundamentals:** Image Representation, basic relationship between pixels, elements of DIP system, elements of visual perception- simple image formation model. Vidicon and Digital Camera working principles Brightness, contrast, hue, saturation, Mach band effect **Color image fundamentals-** RGB, CMY, HIS model. 2D sampling, quantization, Grayscale resolution.	**9**
II	**Review of matrix theory:** row and column ordering- Toelpitz, Circulant and Block matrix. **Review of Fourier transform and DFT**- properties of 2D Fourier Transform- FFT- Separable image transforms- Walsh, Hadamard- Discrete Cosine Transform, Haar Transform.	**9**
III	**Image segmentation:** Segmentation and threshold function, Algorithms in thresholding, line detection, edge detection, edge linking by Graph Search Method, Region based segmentation, Matching, Colour segmentation. **Morphological Operations:** Morphological-dilation and erosion, opening and closing, Hit/ miss transforms, **Implementation of image segmentation in real world applications(Demonstration/Assignment only)**	**9**
IV	**Image Enhancement in Spatial domain:** Basic Gret level transforms, Histogram, Histogram processing: equalization, Image subtraction, Image averaging. Smoothening and sharpening filters, Laplacian Filters. **Image Enhancement in Frequency domain:** Smoothing frequency domain filtering, Sharpening frequency domain filtering, Homomorphic filtering.	**9**

V	**Image compression:** Need for image compression, Huffman, Run length Encoding, Shift codes, vector quantization, transform coding. Basics of image compression standards- JPEG, MPEG. **Image restoration:** Inverse filtering, Least Mean Square filtering, Weiner filtering, Blind image Restoration. MATLAB implementation of Image Processing (Image Compression and Image Restoration, Image smoothening).	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44E	MECHATRONICS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces the fundamentals of Mechatronics, focusing on the integration of mechanical, electrical, electronic, and control systems. Students will explore Computer Numerical Control (CNC) machine components, system modeling in various physical domains, and control systems including PLCs.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the design process and integrated design issues in mechatronics systems and classify various types of sensors and actuators based on their characteristics in mechatronics.	Understand
CO2	Illustrate the fabrication methods working principles of MEMS, accelerometers, and gyroscopes.	Understand
CO3	Explain the design of CNC machine components and the basic principles of system modeling for mechanical, electrical, fluid, and thermal systems.	Understand
CO4	Apply control systems and PLC programming to develop ladder programs for Mechatronics systems.	Apply
CO5	Explain the mechatronics in robotics and robotic vision system.	Understand

iii) SYLLABUS

Introduction to Mechatronics: Structure of Mechatronics system-Sensors-Actuators-Micro Electromechanical Systems (MEMS)-Development of simple hydraulic and pneumatic circuits using standard Symbols-Mechatronics in Computer Numerical Control (CNC) machines. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC)-Case studies of Mechatronics Systems-Mechatronics in Robotics-Electrical Drives-Robotic vision system.

iv) (a) TEXT BOOKS

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007
2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.
4. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, 2nd Edition, Cengage Learning 2012.
5. Robort H Bishop, “Mechatronics an Introduction”, Taylor andFrancis, 2nd edition, 2003.
6. Annalisa Melilla, Donato Di Paola and GraziaCicirelli, “Mechatronic Systems, Applications”, InTech publisher, 2010.
7. William B. Ribbens, Norman P. Mansour, “Understanding Automotive Electronics”, 6th edition, Elsevier Science, 2013
8. M. D. Singh, J. G. Joshi, “Mechatronics”, Prentice Hall of India Private limited, 2006.

(b) REFERENCES

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and
5. MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England,2006.

v) COURSE PLAN

Module	Contents	No. of hours
I	Definition of mechatronics - Traditional vs mechatronics approaches - Mechatronics design process - Need of design tools integration - Review of key elements of mechatronics systems from integration perspective. Mechatronics design concept and framework - overview of mechatronics key elements definition of mechatronics: sequential integration and concurrent integration - integrated design issues in mechatronics - Introduction to real time interfacing elements of data acquisition and control system -Sensors – Characteristics. Actuators: Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators. Smart sensing and digitalization.	**10**
II	Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope, AI-based filtering & fusion in MEMS.	**9**
III	Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Mechatronics elements – Machine structure: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. Measuring system for NC machines - direct and indirect measuring system. System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems, Smart Industry-4.0 machines.	**9**
IV	Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing, SCADA and IoT Integration. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes. Case studies of Mechatronics systems.	**8**
V	Need of mechatronics in automobiles. modelling and simulation antilock braking system – power steering – adaptive cruise control – active suspension system – case studies in vehicle communication - Hybrid EV- electronic ignition – engine control system – tyre pressure monitoring system -Mechatronics in Robotics-Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Force and tactile sensors. Range finders: ultrasonic and light-based range finders. Robotic vision system- Image acquisition: Vidicon, charge coupled	**9**

	device (CCD) and charge injection device (CID) cameras. ADAS and EV intelligence.	
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44F	PROGRAMMING PARADIGMS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

The course offers learners a comprehensive understanding of the core principles of modern programming languages and the key design philosophies behind them. It covers topics such as names, bindings, and scope; statement-level control structures; subprograms; object oriented programming support; exception handling; concurrency control; functional programming; and logic programming. Learners gain the knowledge needed to critically evaluate existing and emerging programming languages, select the most suitable language for a specific task, apply language-specific structures to organize code effectively, classify languages based on their features, and contribute to the design of next-generation programming languages.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages	Understand
CO2	Utilize primitive and user-defined data types, type conversions, Understand and expressions to implement type-safe code	Apply
CO3	Build computational problem solutions by integrating control Apply flow structures and subprograms.	Apply
CO4	Explain the characteristics of Object-Oriented Programming Languages	Understand
CO5	Compare concurrency constructs in different programming languages	Understand

iii) SYLLABUS

Study of programming language concepts, programming domains, evaluation criteria, and language design trade-offs. Implementation methods, names, variables, binding, scope, lifetime, and referencing environments. Data types including primitive, character strings, user-defined ordinal types, arrays, records, lists, pointers, and references. Type checking, strong typing, type equivalence, expressions, assignment statements, and type conversions. Control structures: selection, iteration, unconditional branching, and guarded commands. Subprograms: design issues, referencing environments, parameter passing, closures, and coroutines. Object-oriented programming concepts, inheritance, dynamic binding, C++ support, and implementation. Exception handling concepts and design. Concurrency at subprogram level using semaphores, monitors, and message passing. Introduction to functional programming with LISP and Scheme, comparison with imperative languages, and basics of logic programming with Prolog.

iv) (a) TEXT BOOKS

1) Robert W Sebesta, Concepts of Programming Languages, 10th Edition, Pearson, 2012.
2) Scott M L, Programming Language Pragmatics, 3rd Edition, Morgan Kauffman Publishers, 2009.
3) Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edition, TMH, 2007.

(b) REFERENCES

1) Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edition, Cengage Learning, 2002.
2) Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edition., Pearson Education, 1996.
3) David A. Watt, Programming Language Design Concepts, Wiley Dreamtech, 2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Reasons for studying Concepts of programming languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade- offs, Implementation Methods, Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.	**8**

II	Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer and Reference Types, Implementation of pointer and reference types, Type Checking, Strong Typing, Type Equivalence, Expressions and Assignment Statements, Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation, Assignment Statements, Mixed-mode Assignment.	**9**
III	Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands, Subprograms: Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines	**10**
IV	Support for object oriented programming-Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-Oriented Constructs, Exception Handling – Basic Concepts, Exception Handling - Design Issues	**9**
V	Concurrency- Subprogram Level Concurrency, Semaphores, Monitors, Message Passing, Functional programming languages-Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages, Basic elements of Prolog, Applications of Logic Programming	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44G	CRYPTOGRAPHY	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This course introduces the fundamentals of classical and modern cryptography, covering symmetric and asymmetric encryption, hashing, authentication, and key management. It emphasizes secure communication protocols, real-world cryptographic systems, and emerging trends, preparing students for secure system design and cryptographic application in cybersecurity, networking, and blockchain technologies.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the principles of cryptographic security, classical ciphers, and the need for data protection.	Understand
CO2	Demonstrate the structure and operation of modern symmetric key algorithms such as AES and IDEA.	Understand
CO3	Explain the functioning of public key cryptographic methods like RSA, ECC, and their key management techniques.	Understand
CO4	Illustrate the role of hashing, message authentication codes, and digital signatures in ensuring integrity and authenticity.	Understand
CO5	Summarize real-world applications of cryptography in secure communication, blockchain, and emerging technologies.	Understand

iii) SYLLABUS

Need for security. Principles of security. Types of attacks. Classical encryption techniques. Stream and block ciphers. Public key vs symmetric key systems. DES, AES, IDEA. Block cipher modes. RSA, ElGamal, ECC. Diffie-Hellman key exchange. Key generation, distribution, and management. Cryptographic hash functions. SHA-256, SHA-512, MD5. MAC, HMAC, CMAC. Digital signatures. X.509 authentication. Public Key Infrastructure (PKI). Applications in secure communication, IoT, and blockchain.

vi) (a) TEXT BOOKS

1) William Stallings, *Cryptography and Network Security Principles and Practice*, Pearson Edu, 6th Edition, 2013.
2) Bruice Schneier, *Applied Cryptography Protocols, Algorithms and source code in C*, 2nd Edition, Wiley, 1996.

(b)REFERENCES

1) Behrouz A. Forouzan, *Cryptography and Network Security*, McGraw Hill, 2nd Edition, 2007.
2) Johannes A. Buchmann, *Introduction to Cryptography*, Springer, 2nd Edition, 2004.
3) DouglasR. Stinson, *Cryptography Theory and Practice*, 3rd Edition, Chapman& Hall/CRC, 2006.
4) Bernard Menezes, *Network Security and Cryptography*, Cengage Learning, 2011.

v)COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Security and Classical Cryptography** Need for information security. Security goals and principles. Types of attacks: passive and active. OSI Security Architecture. Classical encryption techniques: Substitution and transposition techniques. Introduction to Stream ciphers and Block ciphers. Symmetric vs. Asymmetric key cryptosystems. Overview of secure communication channels.	**8**
II	**Symmetric Key Cryptography** Symmetric key cryptography concepts and requirements. Block cipher principles and modes of operation. Advanced Encryption Standard (AES) – structure and operation. International Data Encryption Algorithm (IDEA). Stream ciphers: RC4 and modern usage. Overview of vulnerabilities: Differential and linear cryptanalysis (concept only). Real-world applications of symmetric cryptography (e.g., Wi-Fi encryption, disk encryption).	**9**
III	**Public Key Cryptography and Key Management** Principles of public key cryptosystems. RSA algorithm: working and security considerations. Diffie-Hellman key exchange. ElGamal cryptographic system. Elliptic Curve Cryptography (ECC): motivation and applications. Modern trends: Introduction to Post-Quantum Cryptography (NTRU, Lattice-based schemes – overview only). Key generation, distribution, updating, and compromise handling. Public Key Infrastructure (PKI), Certificates, and X.509.	**10**
IV	**Hashing, Message Authentication and Digital Signatures** Authentication requirements and functions. Message Authentication Code (MAC) and Hash functions. Secure Hash Algorithms: SHA-2 and SHA-3 families. HMAC and CMAC. Digital signatures: RSA and ECDSA. Applications: Blockchain Merkle Trees, Digital certificate verification. Deprecation notes: MD5 and SHA-1 (explained as legacy).	**9**

V	**Applications and Modern Cryptography** Cryptography in secure communication: SSL/TLS, Email security (PGP/GPG), VPNs. Password hashing techniques: bcrypt, scrypt, Argon2. Cryptography in Blockchain and IoT. Introduction to Zero-Knowledge Proofs (concept only). Overview of Homomorphic Encryption (concept only). Cryptographic tools and libraries: OpenSSL, GPG, Python cryptography libraries. Case studies and current research trends.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44H	COMPUTER VISION	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides an introduction to core concepts in image processing and computer vision, including techniques for image enhancement, segmentation, and feature extraction. It covers methods for analyzing motion, 3D structure, and object recognition. Emphasis is placed on practical applications in real-time systems such as surveillance and automated recognition.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain basic image processing techniques for improving image quality.	Understand
CO2	Apply morphological operations and shape analysis techniques to process binary images and extract object features.	Apply
CO3	Explain feature detection and segmentation techniques to process and segment images effectively.	Understand
CO4	Apply motion analysis and 3D reconstruction methods to extract scene information from images.	Apply
CO5	Explain feature extraction and classification techniques based on statistical methods and machine learning.	Understand
CO6	Utilize object recognition techniques and classification methods for tasks such as face detection and real-time visual analysis.	Apply

iii) SYLLABUS

Review of image processing techniques - Digital filters, Mathematical morphology, connectedness, object labelling and counting, Boundary descriptors – Chain codes. Properties of Binary Regions, Feature Detection and Image Synthesis, Edge detection, Geometric features, Hough Transform-Line and curve detection, Segmentation, Shape from X, Photometric stereo, Texture Occluding contour detection. Motion Analysis, Optical Flow, Structure from motion, Object recognition, Bayes rule and ML methods. Eigen faces, Face detection, Face recognition, Application, YOLOv8, Examples of real time applications.

iv) (a) TEXT BOOKS

1. E. R. Davies, Computer and Machine Vision -Theory Algorithm and Practicalities, Academic Press, 2012
2. Aston Richard Szeliski, Computer Vision: Algorithms and Applications, ISBN 978-1-84882-935-0, Springer 2011.
3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson India, 2002.
4. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018.

(b)REFERENCES

1. Simon Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2006.
2. Daniel Lelis Baggio, Khvedchenia Ievgen, Shervin Emam, David Millan Escriva, Naureen Mahmoo, Jason Saragi, Roy Shilkrot, Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing Limited, 2012
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
4. R. J. Schalkoff, Digital Image Processing and Computer Vision, John Wiley, 2004.
5. D. L. Baggio et al., ―Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing, 2012.
6. Jan Erik Solem, Programming Computer Vision with Python Tools and algorithms for analyzing images, O'Reilly Media, 2012. Learning with Python, Manning Publications Co.,2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Basic Image Processing Techniques**: Image filtering, Image enhancement: Low pass and high pass filters-Ideal, Gaussian, Butterworth**,** Homomorphic filtering, Point operators - histogram equalization, Adaptive histogram equalization (CLAHE), Neighborhood operators, Thresholding.	**10**
II	**Mathematical Morphology**- erosion, dilation, opening, closing, and hit-or-miss transform for binary image analysis, binary shape analysis -connected components, labelling, counting objects, Boundary descriptors – chain codes, Geometric features- aspect ratio, compactness, area, and perimeter, Statistical shape properties: shape analysis using moments and central moments	**9**

III	**Feature detection and image segmentation**: Edge detection – Canny algorithm, line and curve detection – Hough Transform, active contours, corner detection – Harris corner detector. Basic segmentation techniques- Thresholding (global, adaptive), edge based segmentation, Region based Segmentation(Region growing),split and merge algorithm, Segment Anything Model (SAM), SuperPoint or ORB	**9**
IV	**Motion and 3D construction**: Shape from X - Shape from shading, Photometric stereo, Texture Occluding contour detection. Motion Analysis- Regularization theory, Optical flow: Horn-Shunck method, Lucas-Kanade method. Structure from motion.	**8**
V	**Object Recognition and Real-Time Vision Applications**: Principal Component Analysis (PCA), Support Vector Machines (SVM), Linear Discriminant Analysis (LDA), Bayesian and Maximum Likelihood methods, face detection and recognition: techniques for detecting and recognizing faces using image processing. YOLOv8 for real-time detection, Real-time applications: surveillance, scene analysis.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL44I	DATA ANALYTICS FOR ELECTRICAL ENGINEERS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides foundational and advanced data analytics concepts with a specific focus on applications in Electrical and Computer Engineering. It covers statistical analysis, machine learning algorithms, and real-world applications such as signal processing, smart grid analytics, and embedded system monitoring.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply data collection, cleaning, and exploratory data analysis techniques using Python tools	Apply
CO2	Apply probability and statistical inference techniques using Python for data analysis.	Apply
CO3	Apply supervised learning algorithms for classification and regression to solve data analytics problems.	Apply
CO4	Make use of clustering methods and dimensionality reduction techniques to process complex datasets.	Apply
CO5	Apply data analytics techniques using Python for forecasting and decision making.	Apply

iii) SYLLABUS

Introduction to Data Analytics: Overview and role of data analytics, Descriptive statistics and data visualization, Introduction to Python libraries: NumPy, Pandas, Matplotlib.

Probability and Statistical Inference: Probability theory, random variables, distributions, Hypothesis testing, confidence intervals, Correlation and regression analysis.

Supervised Learning: Linear and logistic regression, Decision trees, random forests, Support vector machines (SVMs). Unsupervised Learning & Dimensionality Reduction: K-means and hierarchical clustering, Principal Component Analysis (PCA), t-SNE, Feature selection methods. Applications of Data Analytics.

iv) (a) TEXT BOOKS

1) Aurelien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd Edition, O'Reilly, 2023.
2) Wes McKinney, *Python for Data Analysis*, 3rd Edition, O'Reilly, 2022.
3) Montgomery, D. C., & Runger, G. C., *Applied Statistics and Probability for Engineers*, 7th Edition, Wiley, 2018.

(b) REFERENCES

1) James, G., Witten, D., Hastie, T., & Tibshirani, R.,
An Introduction to Statistical Learning with Applications in Python, 2nd Edition, Springer, 2023.
2) Kuhn, M., & Johnson, K., *Applied Predictive Modeling*, Springer, 2013.
3) Jake VanderPlas, *Python Data Science Handbook*, O'Reilly, 2022.
4) Chollet, F., *Deep Learning with Python*, 2nd Edition, Manning, 2021.
Bishop, C. M., *Pattern Recognition and Machine Learning*, Springer, 2006.

v) COURSE PLAN

Module	Contents	No. of hours
I	Types of data: structured, unstructured, time-series, categorical, Data collection methods and sensors in systems. Data cleaning: handling missing data, outliers, noise reduction. Exploratory Data Analysis (EDA): Descriptive statistics (mean, median, variance, standard deviation), Data visualization techniques: histograms, boxplots, scatter plots. Python Packages: NumPy, Pandas, Matplotlib, and Seaborn. Case studies using Python.	**9**
II	Probability concepts: conditional probability, Bayes' theorem, Random variables: discrete and continuous, distributions, Central Limit Theorem and Law of Large Numbers, Estimation techniques and confidence intervals, Hypothesis testing: z-test, t-test, chi-square test. Correlation, covariance, and simple regression, Case Study: Statistical Analysis using Python.	**9**
III	Overview of supervised learning and model evaluation metrics. Linear regression, Logistic regression and classification metrics, Decision trees and ensemble methods: Bagging, Random Forests, Gradient Boosted Trees. Support Vector Machines (SVM), k-Nearest Neighbors (kNN) algorithm, Case Study of Supervised learning algorithm using Python to solve real world problems.	**9**
IV	Unsupervised Learning: Clustering techniques: K-Means, Hierarchical clustering, Dimensionality reduction: Principal Component Analysis (PCA), Feature selection techniques, Data transformation and scaling methods. Case Study using Python.	**8**
V	Applications of data analytics in engineering and real-world systems, including analysis of time-series data, sensor and IoT data, and operational datasets. Data-driven methods for forecasting, trend analysis, anomaly detection, and predictive decision-making. Case studies using Python to analyze and visualize practical datasets from domains such as energy systems, industrial monitoring, and smart applications.	**10**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

PROGRAMME ELECTIVE V

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45A	ENERGY MANAGEMENT	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

The main goal of this course is to enable the students to understand the concept of energy management and energy management opportunities. The course helps the students to understand the different methods used for the economic analysis of energy projects.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the significance of energy management and planning.	Understand
CO2	Summarize energy management opportunities in electric lighting, transformers and motor loads.	Understand
CO3	Identify energy efficiency improvement opportunities in industries and commercial establishments.	Apply
CO4	Explain demand side management techniques.	Understand
CO5	Develop the economic feasibility of the energy conservation measures.	Apply

iii) SYLLABUS

Energy Management - General Principles and Planning. Energy management opportunities in Lighting, Transformers and Motors.

Energy management in industries and commercial establishments- energy conservation opportunities in boilers, steam and furnace. Heat recovery schemes.

Demand side Management- techniques of DSM. Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.

Cogeneration. Energy Economics: Economic analysis: methods. Computer aided Energy Management Systems.

iv) (a) TEXT BOOKS

1) Smith, Craig B.. *Energy Management Principles: Applications, Benefits, Savings. United States:* Pergamon Press, 1981.
2) Gottschalk, Charles M., *Industrial Energy Conservation,* John Wiley, 1996.
3) D. Yogi Goswami, Frank Kreith, *Energy Management and Conservation Handbook*,3rd edition, CRC Press, 2015.
4) G.G. Rajan, *Optimizing Energy Efficiencies in Industry*, Illustrated edition, Tata McGraw Hill, Pub. Co., 2014.

(b) REFERENCES

1) IEEE recommended practice for energy management in industrial and facilities.
2) IEEE std 739 - 1995 (Bronze book).
3) Paul O'Callaghan, Energy management, 2nd edition, McGraw Hill Book Co., 2003.
4) Wayne C. Turner, Energy management Hand Book, 8th edition The Fairmount Press, Inc., 2012.
5) M Jayaraju and Premlet, Introduction to Energy Conservation and Management, 4th edition, Phasor Books, 2016

v) COURSE PLAN

Module	Contents	No. of hours
I	**Energy Management**: General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies. Energy Standard: ISO 500001. **Energy Efficiency in Lighting**: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting, use of sensors and lighting automation.	**9**
II	**Energy Efficiency in Motors:** Development of energy efficient motors and the present status, techniques for improving energy efficiency, necessity for load matching. **Energy efficiency in Transformers:** Present maximum efficiency standards for power and distribution transformers, design measures for increasing efficiency in electrical system components.	**9**
III	**Energy Management in Industries and Commercial Establishments**: Boiler - working principle - blow down, energy conservation opportunities in boiler. Identifying opportunities for energy savings in steam distribution. General fuel economy measures, energy conservation opportunities in furnaces - Case study. **Heat Recovery Systems**: Waste heat recovery system - Energy saving opportunities.	**9**
IV	**Demand side Management (DSM):** Introduction to DSM, benefits of DSM, Different techniques of DSM - time of day pricing, multi-utility power exchange model, time of day models for planning. Load management, load priority technique, strategic conservation, energy efficient equipment. **Cogeneration-**Types and Schemes, Optimal operation of cogeneration plants- Case study.	**9**
V	**Energy Economics**: Economic analysis methods, cash flow model, time value of money, pay-back period, average rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS) – Basic Concepts. Energy audit: Definition, Need, Types of energy audit.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45B	SOLAR PV SYSTEMS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This This course offers an in-depth introduction to the principles, components, and design of Solar Photovoltaic (PV) systems. It covers the fundamental concepts of solar energy, including solar radiation measurements and solar spectrum analysis, and gradually builds up to system design and grid integration. The course also introduces simulation tools for PV system design, life cycle cost analysis, and economic viability assessment.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the basics of solar energy conversion systems.	Understand
CO2	Explain the concepts and applications of solar thermal systems.	Understand
CO3	Outline the key parameters of PV modules and explain the various Maximum Power Point Tracking methods.	Understand
CO4	Model the components of solar photovoltaic systems using the advanced PV technologies.	Apply
CO5	Demonstrate the overcurrent protection methods and economics of PV Systems.	Understand

iii) SYLLABUS

Source of Solar Energy- Solar Constant - Solar Radiation on a Horizontal Surface - Solar Radiation on an Inclined Surface - Monthly Average Daily Solar Radiation on Inclined Surfaces. Solar Thermal System - Solar thermal collectors, Solar concentrators - Solar cooker, Solar Furnace, Solar Greenhouse, Solar Water Heater, Heric topology. Solar PV Systems - Solar Cell (Photovoltaic) Materials - Photovoltaic (PV) Module and PV Array, Packing Factor of the PV Module - Effect of shadowing - MPPT Techniques.

Solar PV Systems- Design of Standalone System, Grid Interactive PV System, Bifacial solar modules and floating solar farms, Building-Integrated Photovoltaics (BIPV), Solar PV in electric vehicles and charging stations, Agri-voltaic and solar desalination. Protection Against Islanding and Reverse Power Flow –EMI Filters.

Overcurrent protection of solar PV power system, Life cycle costing, Growth models. Introduction to simulation software for solar PV system design.

iv) (a)TEXT BOOKS

1. Chetan Singh Solanki, Renewable Energy Technologies: A practical guide for beginners, 3rd Edition, PHI.
2. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3rd Edition, PHI.
3. D.P. Kothari, M Jamil, Grid Integration of Solar Photovoltaic Systems, CRC Press, 2018.
4. G. N. Tiwari: Solar Energy: Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002.
5. John A. Duffie and William A. Beckman, *Solar Engineering of Thermal Processes*, 5th ed., John Wiley & Sons, 2020
6. A.A.M. Saigh (Ed), Solar Energy Engineering, Academic Press, 1977.

(b)REFERENCES

1. Masters, Gilbert M., *Renewable and Efficient Electric Power Systems*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.
2. Thomas E. Kissell, David M. Buchla, Thomas L. Floyd, *Renewable Energy Systems*, Pearson, 2017.
3. G. N. Tiwari, Arvind Tiwari, Shyam, *Handbook of Solar Energy: Theory, Analysis and Applications*, Springer, 2016.
4. Khan B. H., *Non-Conventional Energy Resources*, Tata McGraw Hill, 2009.
5. D.P. Kothari, K.C. Singal, Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2009.
6. S. Rao and B. B. Parulekar, *Energy Technology: Nonconventional, Renewable and Conventional*, 3rd ed., Khanna Publishers, 2013.
7. Sawhney G. S., *Non-Conventional Energy Resources*, PHI Learning, 2012.
8. Abbasi S. A. and N. Abbasi, *Renewable Energy Sources and their Environmental Impact*, Prentice Hall of India, 2001.
9. Godfrey Boyle (Ed.), *Renewable Energy: Power for a Sustainable Future*, 3rd ed., Oxford University Press, 2012.
10. Tara Chandra Kandpal, Hari Prakash Garg, *Financial evaluation of Renewable Energy Technologies*, Mac Millam India Limited, 2003.
11. IEEE Application Guide for IEEE Std 1547(TM), *IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems*, in IEEE Std 1547.2-2008, pp.1217, 15 April 2009.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction - Sun and Earth, Solar Spectrum, Solar Geometry, Solar radiation on horizontal and inclined planes, Instruments for measurement of solar radiation, Extra-terrestrial Region - Terrestrial Region, Solar radiation at a given location - Daily Radiation Pattern, Annual Variation in Solar Radiation, Optimal Tilt for Solar Equipment, Monthly Averaged Global Radiation at Optimal Tilt.	**10**
II	Solar Thermal system - Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors – Flat plate collectors and its types – Heat transfer processes – Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) Applications - Solar Cooking Systems- Principle of cooking. Speed of cooking- Energy required for cooking, Types of Solar cooker-Box type solar cooker-Dish type solar cooker- Heat Transfer type solar cooker, Solar Furnace, Solar Greenhouse, Solar Water Heater (flat plate). Fresnal lens, Heric topology, Design of solar pond, Solar desalination plant, Solar butane plant	**9**
III	Solar PV Systems-Introduction - Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect - Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell, Photovoltaic (PV) Module and PV Array – Single - Crystal Solar Cell Module, Thin-Film PV Modules, Emerging and New PV Systems - Packing Factor of the PV Module - Efficiency of the PV Module - Energy Balance Equations for PV Modules -Series and Parallel Combination of PV Modules.- Effect of shadowing-MPPT Techniques - P&O, incremental conductance method. Peroxide solar cell, Study of lead acid battery, design of battery building integrated pv system, solar PV material.	**9**
IV	Solar Photovoltaic systems - Types, General design considerations, System sizing, Battery sizing, Inverter sizing, Design examples, Balance of PV systems. Cost estimation of a PV system, Solar PV Lantern -Design and Costing, Grid Interactive PV System- Advanced PV Applications: Bifacial solar modules and floating solar farms, Building-Integrated Photovoltaics (BIPV), Solar PV in electric vehicles and charging stations, Agri-voltaics and solar desalination.	**8**

V	Protection Against Islanding and Reverse Power Flow – EMI Filters. Overcurrent protection of solar PV power system, Selective fuse links for PV String protection, PV fuse selection flow chart, Fuse rating for PV Applications. Life cycle costing, Growth models, Annual payment and present worth factor, payback period, LCC with examples. Introduction to simulation software for solar PV system design.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45C	POWER SYSTEM PROTECTION	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental concepts of generation, transmission and distribution of electric power. The course also intends to deliver the basic concepts of power system protection including the different types of relays and circuit breakers.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the need for protective schemes and classify different types of electrical faults and their effects on power systems.	Understand
CO2	Illustrate the operating principles and characteristics of electromechanical, static, numerical relays, and microprocessor based relay used in protection systems.	Understand
CO3	Interpret the principles and settings of overcurrent protection schemes and compare different types of overcurrent relays.	Understand
CO4	Summarize the working and characteristics of distance protection relays and assess their performance under different fault conditions.	Understand
CO5	Illustrate the concepts and components of differential protection, pilot relaying schemes, and circuit breaker operation with reference to power system protection.	Understand

iii) SYLLABUS

Introduction to Power System Protection.
Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays, Microprocessor relay and Numerical Relays. Overcurrent Protection, Distance Protection. Pilot Relaying Schemes: Introduction, Wire Pilot Protection, Carrier Current Protection. Differential Protection, Rotating Machines Protection
Transformer and Buszone Protection: Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection. Circuit Breakers: Operating Principle and Types.

vi) (a) TEXT BOOKS

1) Bhuvanesh Oza, Nirmal Kumar Nair, Rashesh Mehta, *Power System Protection and Switchgear*, Tata McGraw Hill, 1st edition, 2017.
2) Badri Ram and D. N. Vishwakarma, *Power System Protection and Switchgear*, 3rd ed., McGraw Hill, 2022.

3) J. B. Gupta, *A Course in Electrical Power*, S. K. Kataria & Sons, 11th ed., 2025.

(b)REFERENCES

1) B. Bhalja, R. P. Maheshwari, and N. G. Chothani, *Protection and Switchgear*, 2nd ed. New Delhi, India: Oxford Univ. Press, 2018.
2) Sunil S. Rao, *Switchgear and Protection*, Khanna Publishers, 2nd edition, 2012.
3) N. Veerappan S.R. Krishnamurthy, *Power System Switchgear and Protection*, S. Chand, 1st edition, 2009.
4) Y. G. Paithankar and S. R. Bhide, *Fundamentals of Power System Protection*, 2nd ed., PHI Learning, 2010 .

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Power System Protection:** Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers and Voltage Transformers for Protection.	9
II	**Relay Construction and Operating Principles:** Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Microprocessor based relay. **Overcurrent Protection:** Introduction, Time–current Characteristics, Current and Time Setting, Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.	9
III	**Distance Protection:** Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Introduction to MicroGrid- MicroGrid Protection- Communication Aided Protection, AI and Advanced Sensing, Hybrid AC-DC Protection.	9
IV	**Pilot Relaying Schemes:** Introduction, Wire Pilot Protection, Carrier Current Protection, Merz price, circulating current scheme, carrier current scheme **Differential Protection:** Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection. **Rotating Machines Protection:** Introduction, Generator Protection- (Numerical problems). **Transformer and Bus zone**	9

	Protection: Introduction, Transformer Protection, Bus zone Protection, Frame Leakage Protection.	
V	**Circuit Breakers:** Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Rate of rise of recovery voltage-natural frequency of oscillating, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45D	ROBOTICS AND ARTIFICIAL INTELLIGENCE	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides an introduction to the key concepts in robotics and artificial intelligence, covering topics such as robot kinematics, perception, control, AI, machine learning, and their applications in autonomous systems.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the concepts of intelligent sensing, sensor fusion, and the role of distributed control in autonomous systems.	Understand
CO2	Make use of vision and perception for real-time robotic control and autonomy.	Apply
CO3	Explain the role of artificial intelligence and machine learning in enhancing robot adaptability and autonomy.	Understand
CO4	Demonstrate Reinforcement Learning and adaptive intelligent based control techniques and HRI for robotic applications.	Understand
CO5	Explain the recent trends, ethical and societal Aspects in robotic systems	Apply

iii) SYLLABUS

Advanced Robot Architectures, Real-time operating systems for robotics. Intelligent Sensor Integration. Sensor Network and Communication.

Perception and Computer Vision in Robotics: Robotic Perception, SLAM (Simultaneous Localization and Mapping). Computer Vision for Robotics. Visual Servoing. Applications and control strategies.

AI in Robotics, Machine Learning for Robots. Deep Learning in Robotics. Introduction to policy learning and behavior cloning.

Robot Learning, Control, and Human-Robot Interaction (HRI): Reinforcement Learning in Robotics. Adaptive and Intelligent Control. Human-Robot Interaction (HRI).

Autonomous Systems. Robotics in Smart Industries. Robotics in Smart Industries - collaborative robots Ethical and Societal Aspects. Research Trends

iv) (a) TEXT BOOKS

1) Lentin Joseph, *"Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy"*, Apress, 2018.

2) Sebastian Thrun, Wolfram Burgard, and Dieter Fox, *"Probabilistic Robotics"*, MIT Press, 2005.
3) Richard Szeliski, *"Computer Vision: Algorithms and Applications"*, 2nd Edition, Springer, 2022.
4) Francis X. Govers, *"Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques"*, Packt Publishing, 2018.
5) Mohammad S. Obaidat, Nasir Ghani, *"Autonomous Robots and Systems: A Comprehensive Introduction"*, Springer, 2023.
6) A.K. Gupta and S.K. Arora, *"Robotics and Industrial Automation: A Handbook"*, 3rd Edition, Laxmi Publications, 2013.

(b) REFERENCES

1) Kevin M. Lynch and Frank C. Park, *"Modern Robotics: Mechanics, Planning, and Control"*, Cambridge University Press, 2017.
2) Kazem Sohraby, Daniel Minoli, and Taieb Znati, "*Wireless Sensor Networks: Technology, Protocols, and Application",* Wiley-Interscience, 2007.
3) Peter Corke, *"Robotics, Vision and Control: Fundamental Algorithms in MATLAB"*, 2nd Edition, Springer, 2017.
4) Timothy D. Barfoot, *"Simultaneous Localization and Mapping: Exactly Sparse Information Filters"*, Morgan & Claypool Publishers, 2011.
5) Joseph Howse et al., *"Deep Learning for Robot Vision"*, Packt Publishing, 2019.
6) Stuart Russell and Peter Norvig, *"Artificial Intelligence: A Modern Approach"*, 4th Edition, Pearson, 2020.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Advanced Robot Architectures and Intelligent Sensors:** Advanced Robot Architectures - Distributed and centralized control architectures, Real-time operating systems for robotics, Middleware in robotics: ROS (Robot Operating System) overview. Intelligent Sensor Integration - Multisensor fusion techniques, Smart sensors and self-calibration, Vision sensors with embedded AI Sensor Network and Communication - IoT in robotics, Wireless sensor networks (WSNs), Communication protocols (CAN, RS485, ROS topics, MQTT).	**9**
II	**Perception and Computer Vision in Robotics:** Robotic Perception Basics - Concept of environment mapping, SLAM (Simultaneous Localization and Mapping): Overview and techniques (2D & 3D), Occupancy grids, landmark-based mapping. Computer Vision for Robotics - Feature extraction and matching (SIFT, SURF, ORB), Object detection and classification (Haar, HOG, YOLO, SSD), Depth estimation and stereo vision. Visual Servoing - Image-based vs Position-based visual servoing, Applications and control strategies.	**9**

III	**Artificial Intelligence and Machine Learning in Robotics:** AI in Robotics - Introduction to AI: Agents, environments, decision making, Path planning using AI (A*, Dijkstra, RRT), Expert systems and fuzzy logic control. Machine Learning for Robots - Supervised, unsupervised, and reinforcement learning, Model-free vs model-based learning. Deep Learning in Robotics - CNNs for vision tasks, Recurrent networks for sequence prediction, Introduction to policy learning and behavior cloning.	**9**
IV	**Robot Learning, Control, and Human-Robot Interaction (HRI):** Reinforcement Learning in Robotics - MDPs and policy optimization, Q-learning, Deep Q Networks (DQN). Applications in motion control and decision-making. Adaptive and Intelligent Control - Adaptive PID, fuzzy logic control, Model Predictive Control (MPC), Learning-based control (LQR, neural controllers). Human-Robot Interaction (HRI) - Types of HRI: teleoperation, collaborative, social. Emotion and gesture recognition. Safety in HRI, standards, and design principles.	**9**
V	**Applications and Trends in Robotics and AI:** Autonomous Systems - Mobile robot navigation: mapping, localization, obstacle avoidance. Self-driving cars - Drones and aerial autonomy. Robotics in Smart Industries - collaborative robots (cobots), Predictive maintenance and digital twins. Ethical and Societal Aspects - Ethics of AI in robotics, Explainable AI (XAI) in robotic systems. Legal and societal implications. Research Trends & Case Studies - Boston Dynamics, OpenAI Robotics, Tesla FSD	**9**
	Total	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45E	NONLINEAR SYSTEMS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The course aims in understanding the behavior of nonlinear systems, analyze their stability using the Lyapunov direct/indirect methods, frequency-domain methods and design various control schemes.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Identify the qualitative behaviour of nonlinear systems about their equilibrium points.	Apply
CO2	Demonstrate the existence and uniqueness of solutions of nonlinear differential equations, the existence of periodic orbits/limit cycles for nonlinear systems.	Understand
CO3	Analyse the stability of nonlinear systems using various methods.	Analyse
CO4	Analyse the absolute stability of feedback systems with nonlinearities using Circle Criterion and Popov Criterion.	Analyse
CO5	Develop feedback linearization and stabilization for nonlinear systems.	Apply

iii) SYLLABUS

Non-linear system characteristics and mathematical modelling of a non-linear system, Stability of a nonlinear system based on equilibrium points, Bifurcation, Phase plane analysis of nonlinear systems.

Periodic solution of nonlinear systems and existence of limit cycle, Invariant set theorem, Bendixson's theorem and Poincare-Bendixson criteria, Existence and uniqueness of solutions to nonlinear differential equations, Lipschitz condition.

Lyapunov stability theorems, the direct method of Lyapunov, Construction of Lyapunov functions.

Passivity, KYP Lemma, Absolute stability, Circle Criterion, Popov Criterion.

Feedback linearization, Stabilization.

iv)(a) TEXT BOOKS

1) Khalil H. K., “Nonlinear Systems”, 3rd Edition, Pearson, 2002
2) Gibson J. E., “Nonlinear Automatic Control”, Mc Graw Hill, 1963
3) Slotine J. E. and Weiping Li, “Applied Nonlinear Control”, Prentice-Hall, 1991.

(b) REFERENCES

1) Alberto Isidori, “Nonlinear Control Systems: An Introduction”, Springer-Verlag, 1985.
2) M. Vidyasagar, “Nonlinear Systems Analysis”, Prentice-Hall, India, 1991.
3) Shankar Sastry, “Nonlinear System Analysis, Stability and Control”, Springer, 1999.

v) COURSE PLAN

Module	Contents	No. of hours
I	Overview of State space model - Non-linear system characteristics and mathematical modelling of a non-linear system, Classification of equilibrium points, Stability of a nonlinear system based on equilibrium points - Phase plane analysis of nonlinear systems.	**9**
II	Periodic solution of nonlinear systems and existence of limit cycle, Open sets, closed sets, connected sets, Invariant set theorem, Bendixson's theorem and Poincare - Bendixson criteria, Existence and uniqueness of solutions to nonlinear differential equations (Proofs not required), Lipschitz condition.	**9**
III	Lyapunov stability theorems (Proofs not required)- local stability - local linearization and stability in the small- region of attraction, the direct method of Lyapunov, Construction of Lyapunov functions - Variable gradient and Krasovskii's methods, La Salles's invariance principle.	**9**
IV	Passivity and loop transformations, KYP Lemma (Proof not required), Absolute stability, Circle Criterion, Popov Criterion.	**9**
V	Feedback linearization, Input state linearization method, Input-output linearization method, Stabilization - regulation via integral control-gain scheduling - case studies	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45F	Cloud Computing	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course provides a foundational understanding of cloud computing concepts, virtualized resources, cloud service models, deployment architectures, and modern cloud platforms, enabling students to design, deploy, and evaluate cloud-based solutions.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the fundamental cloud computing concepts, models, and characteristics, and differentiate cloud from traditional computing approaches.	Understand
CO2	Explain virtualization technologies, virtual resources management, and compare VM-based and container-based approaches.	Understand
CO3	Explain cloud architecture components and commercial cloud platforms, computation, and networking services.	Understand
CO4	Apply cloud security issues, IAM principles, management and compliance requirements in cloud environments.	Apply
CO5	Apply cloud computing for modern application deployment while assessing emerging trends, cloud economics, and future technology directions.	Apply

iii) SYLLABUS

Cloud Computing Basics: Evolution of cloud, definition & characteristics. Service models (SaaS, PaaS, IaaS). Deployment models (Public/Private/Hybrid/Community). Advantages, challenges & use cases.

Virtualization & Containerization: Virtualization fundamentals & hypervisors. Server, storage and network virtualization. VMs vs Containers. Tools overview: VMware, Xen, KVM, Docker, Kubernetes.

Cloud Architecture & Services: Cloud architecture components. Compute, storage, network services. Resource provisioning, auto-scaling. Serverless and microservices. Overview of AWS/Azure/GCP services.

Cloud Security & Governance: Cloud security threats and IAM. Data privacy & encryption. Multi-tenancy issues. SLAs, monitoring, billing and compliance.

Cloud Applications & Emerging Trends: Cloud application development. DevOps and CI/CD on cloud. Cloud + IoT, AI/ML, Big Data. Multi-cloud, Edge/Fog & Future trends.

iv)(a) TEXTBOOKS

1) Rajkumar Buyya, Christian Vecchiola, and S.T. Selvi, Mastering Cloud Computing, McGraw Hill, 2013.

2) Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.

(b) REFERENCES

1) Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw-Hill, 2010.

2) Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy, O'Reilly, First Edition, 2009.

3) Amazon Web Services Documentation & Azure/AWS/GCP Online Learning Portals (Latest Editions).

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Cloud Computing:** Evolution of computing: Grid vs Cluster vs Cloud. Definition, characteristics and benefits of cloud. Service-oriented architecture. Cloud service delivery models: SaaS, PaaS, IaaS. Deployment models: Public, private, hybrid, community cloud. Essential cloud attributes: elasticity, scalability, pay-per-use.	**8**
II	**Virtualization Technologies**: Virtualization basics: hypervisors, VM lifecycle. Types: server, storage, network virtualization. Resource pooling and consolidation. Containers vs Virtual Machines. VMware, Xen, KVM, Hyper-V overview. Cloud orchestration basics (Docker, Kubernetes)	**9**
III	**Cloud Architecture & Services**: Cloud architecture design principles. Cloud resource provisioning, elasticity and load balancing. Distributed storage systems (HDFS, Object Storage, Block Storage). Cloud APIs and web services. Serverless computing and microservices introduction. Case studies on AWS/Azure/GCP service stacks.	**9**
IV	**Cloud Security, Privacy & Management:** Security challenges and threat models. Identity and Access Management (IAM). Authentication, authorization & multi-tenant security. Data protection, encryption, key management. Service level agreements (SLAs), monitoring & billing. Regulatory compliances and governance (GDPR, HIPAA overview)	**10**
V	**Cloud Applications, Trends & Emerging Technologies:** Cloud application development principles**.** Integration with IoT, Edge & Fog computing**.** Big Data and AI on cloud**.** DevOps and CI/CD pipelines for cloud deployment**.** Role of containers & orchestration tools**.** Future trends: multi-cloud, FinOps, green cloud, quantum cloud vision.	**9**

	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45G	DEEP LEARNING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered in this course. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamentals of Deep Learning, including neural networks, activation functions, and optimization techniques.	Understand
CO 2	Apply Convolutional Neural Networks for Computer Vision applications.	Apply
CO 3	Make use of Recurrent Neural Networks and Long Short-Term Memory networks for Natural Language Processing applications.	Apply
CO 4	Apply various deep learning techniques to improve model performance.	Apply
CO 5	Make use of deep learning models integrating Computer Vision and NLP in real-world scenarios.	Apply

iii) SYLLABUS

Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance. Optimization and Neural Networks: Neural Networks, Multilayer perceptron, activation functions, architecture design. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges. Convolutional Neural Network: Convolutional Neural Networks ,Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks. Applications – computer vision, speech recognition, natural language processing. Research Areas – Autoencoders, Representation learning, Boltzmann Machines, Deep belief networks.

iv) (a) TEXT BOOKS

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.

2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.

Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

(b) REFERENCES

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J Marksll, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md.Rezaul Karim, Pradeep Pujari, Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python bySudharsan Ravichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet, Manning Publications Co.,2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Deep Learning: Fundamentals of Deep Learning and AI: Definition of AI, Machine Learning, and Deep Learning, Evolution of Neural Networks and DL applications in Computer Vision & NLP, Difference between Machine Learning and Deep Learning. Mathematical Foundations for Deep Learning: Linear Algebra: Vectors, Matrices, Eigenvalues, Eigenvectors, Probability & Statistics: Basics, Bayes' theorem, Probability Distributions, Optimization: Gradient Descent, Stochastic Gradient Descent (SGD), Cost functions. Introduction to Artificial Neural Networks (ANN): Perceptron Model: Neurons, Weights, and Bias, Activation Functions: Sigmoid, ReLU, SoftMax, Forward and Backpropagation: Chain rule, Loss functions (MSE, Cross-Entropy).	9
II	Basics of Computer Vision & Image Processing: Understanding Images: Pixels, RGB, Grayscale, Image Representation, Image Filtering: Edge Detection, Gaussian Blur, Convolution basics, Feature Extraction and its importance in Deep Learning. Concept of Convolutions and Feature Maps, Padding, Stride, and Pooling (Max, Average), Fully Connected Layers in CNNs. CNN Architectures. Famous CNN Architectures: LeNet, AlexNet, VGG, ResNet (Overview). Hands-on: Implementing a CNN using Keras for Image Classification (sample datasets)	9
III	Introduction to NLP and Word Embeddings: NLP Basics: Tokenization, Lemmatization, Stopwords Removal, One-hot Encoding vs. Word Embeddings, Recurrent Neural Networks & LSTMs: Working of RNNs: Sequential Data Processing, Hidden States, Issues with RNNs: Vanishing Gradient Problem, LSTM & GRU: Gating Mechanisms, Hands-on NLP Applications: Text Classification using LSTM, Sentiment Analysis using	9

	IMDb dataset in Keras, Named Entity Recognition (NER), Transformer Architectures (Basic Concepts Only).	
IV	Hyperparameter Tuning & Optimization: Regularization: L1, L2, Dropout, Batch Normalization: Why and How, Learning Rate Scheduling and Optimizers (SGD, Adam, RMSprop). Transfer Learning & Pre-trained Models: Concept of Transfer Learning, Using Pre-trained CNN Models (VGG16, ResNet, MobileNet) for Image Classification, Fine-Tuning Layers for Specific Tasks. Hands-on Implementation of Transfer Learning: Implementing a Pre-trained Model in TensorFlow, Comparing Training Speed and Performance Improvements	**8**
V	Introduction to Generative Adversarial Networks (GANs) (Basic Concept), Autoencoders for Image Denoising, Applications of Deep Learning, DL in Healthcare (Medical Image Analysis), DL in Finance (Fraud Detection), DL in Robotics (Autonomous Systems), Implementing a Deep Learning Model (CNN or LSTM) for a real- world problem, Training, Testing, and Deployment, Responsible AI : Bias and fairness in datasets, Hallucinations in large language models, Data privacy and security concerns, Model misuse and societal impact.	**10**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL45H	BIOINFORMATICS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course is designed to introduce students to the core concepts of bioinformatics, bridging the gap between biology and computer science. The course emphasizes algorithms, biological databases, sequence analysis, data visualization, and machine learning applications in the context of modern biology and healthcare.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the foundational concepts of bioinformatics and molecular biology	Understand
CO2	Explain sequence alignment techniques and interpret phylogenetic relationships using computational tools.	Understand
CO3	Apply genomic and proteomic data to predict gene structures and protein conformations using bioinformatics tools and databases.	Apply
CO4	Develop Python scripts and automation tools to parse, analyse, and visualize biological sequence.	Apply
CO5	Explain Artificial neural network and applications of bioinformatics in drug discovery, systems biology, healthcare, and IoT.	Understand

iii) SYLLABUS

Introduction to Bioinformatics & Biological Databases: Scope of bioinformatics in engineering, Basic of molecular biology -, Sequence formats - FASTA, GenBank, GFF, Database searching and retrieval techniques. Introduction to Ensemble and UCSC Genome Browser, of FAIR data principles and biomedical data governance (Concept only), Role of bioinformatics in healthcare and biomedical engineering. Sequence Alignment and Phylogenetics, tree construction and interpretation- Conceptual introduction to NGS alignment tools (e.g., STAR, HISAT2), performance evaluation metrics (accuracy, sensitivity), Phylogenetic tree construction and interpretation. Genomics, Proteomics and Structural Bioinformatics, Tools: ORF Finder, ExPASy, SWISS-MODEL, Structural databases and visualization tools, AI-based protein prediction concepts -AlphaFold-like models. Programming and Data Analysis in Bioinformatics, Introduction to Biopython and Pandas for omics data. Artificial Neural Network (ANN), Applications and Emerging Trends

iv) (a) TEXT BOOKS

1) Arthur Lesk, *Introduction to Bioinformatics, 4th edition*, OUP Oxford, 2014.
2) S. Harisha, *Fundamentals of Bioinformatics*, I.K. International Publishing House Pvt. Limited, 2013.

3) Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2006.

(b) REFERENCES

1) Gautam B. Singh, Fundamentals of Bioinformatics and Computational Biology: Methods and Exercises in MATLAB, Springer Nature Switzerland, 2025.
2) Miguel Rocha, Pedro G. Ferreira, Bioinformatics Algorithms: Design and Implementation in Python, Elsevier Science, 2018.
3) Richard Durbin, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 1998.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Bioinformatics & Biological Databases:** Scope of bioinformatics in engineering, Basics of molecular biology - DNA, RNA, proteins, Biological databases - NCBI, EMBL, DDBJ, UniProt, PD, Sequence formats - FASTA, GenBank, GFF, Database searching and retrieval techniques. Introduction to Ensemble and UCSC Genome Browser, of FAIR data principles and biomedical data governance (Concept only), Role of bioinformatics in healthcare and biomedical engineering	**9**
II	**Sequence Alignment and Phylogenetics:** Sequence alignment - local vs. global, Conceptual introduction to NGS alignment tools (e.g., STAR, HISAT2), performance evaluation metrics (accuracy, sensitivity), Needleman-Wunsch, Smith-Waterman. BLAST and FASTA tools. Multiple sequence alignment - ClustalW, MUSCLE. Phylogenetic tree construction and interpretation.	**9**
III	**Genomics, Proteomics and Structural Bioinformatics:** Genome annotation and gene prediction, Protein structure levels: primary to quaternary, Protein structure prediction (homology modeling, threading, ab initio), Tools: ORF Finder, ExPASy, SWISS-MODEL, Structural databases and visualization tools. AI-based protein prediction concepts -AlphaFold-like models.	**9**
IV	**Programming and Data Analysis in Bioinformatics:** Introduction to Python for bioinformatics, Introduction to Biopython and Pandas for omics data- File handling - Parsing FASTA, FASTQ, Sequence manipulation and pattern matching, Regular expressions and automation using shell scripting, Data visualization using Python (matplotlib, seaborn).	**8**
V	**Artificial Neural Network (ANN):**Basics and introduction to terminologies, Supervised and non-supervised learning, Feed forward back propagation error method, Application of ANN methods: Protein sub-cellular localization and secondary structure prediction-Applications and Emerging Trends: Drug discovery and molecular docking basics, Systems biology and network modeling,	**10**

	Machine learning applications in bioinformatics, Bioinformatics in healthcare and IoT-based biosensing, Ethical issues, data privacy and regulation in bioinformatics. case studies on disease prediction	
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

PROGRAMME ELECTIVE VI

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46A	SPECIAL ELECTRIC MACHINES	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces special electric machines from an application-oriented and system-level perspective, focusing on their role in electric drives, motion control systems, industrial automation, and electric mobility. Emphasis is placed on operating principles, control interfaces, and application relevance rather than analytical derivations.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Illustrate the operating principle and applications of Permanent magnet DC motors, Brushless DC motors, and Permanent Magnet Synchronous Motors.	Understand
CO2	Outline the working principles and application-oriented features of Stepper and Servo-based motion control systems.	Understand
CO3	Explain the operating principle and control challenges of Synchronous and Switched Reluctance Motors in modern drive applications.	Understand
CO4	Outline the principle and applications of single phase motors used in automated systems.	Understand
CO5	Explain the principles and applications of Linear electric machines used in transportation systems.	Understand

iii) SYLLABUS

Permanent Magnet Machines in Drives – PMDC and BLDC motors: basic construction and principle of operation – electronic commutation– Permanent Magnet Synchronous Motor – basic construction and principle of operation.

Stepper motors: basic principle – classification – excitation methods – micro stepping– applications. Servo systems: AC and DC servomotors – basic working principle – characteristics – comparison – applications in automation.

Reluctance Machines – Synchronous Reluctance Motor and Switched Reluctance Motor: basic operating principles – converter- control concepts–applications.

Universal motor, AC series motors, Repulsion motor, Hysteresis motors: principle of operation – speed control -applications in household and industrial appliances.

Linear induction motor: principle of operation – thrust production-end effects– applications; Linear levitation machines.

iv) (a) TEXT BOOKS

1) E. G. Janardanan, "Special Electrical Machines", PHI Learning Private Limited, 2014.
2) Theodore Wildi, "Electric Machines, Drives and Power Systems", Pearson Education, 5th Edition, 2013.
3) T. J. E. Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.

(b) REFERENCES

1) Irving L. Kosow, "Electrical Machinery and Transformers", Pearson, 2nd Edition, 2007.
2) Paul Acamley, "Stepping Motor – A Guide to Theory and Practice", IEE London, 2002.
3) B. K. Bose, "Modern power electronics and AC drives", Prentice Hall of India, N J, 2002.
4) Cyril George Veinott, Joseph E. Martin, "Fractional and Sub fractional Horsepower Electric Motors: Available Types, Basic Operating Principles, Selection, and Maintenance", McGraw-Hill, 4th Edition, 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	**PM Machines in Electric Drives**: Permanent Magnet DC Motors: construction, principle of operation, characteristics, applications. Brushless DC motors – construction, principle, electronic commutation using Hall sensors, square-wave and sinusoidal excitation (concept), applications in electric drives. Permanent Magnet Synchronous Motors – construction and principle (concept only), applications in EVs. BLDC–PMSM comparison.	10
II	**Stepper and Servo-Based Motion Systems**: Stepper motors- variable reluctance and permanent magnet types- construction and principle, various excitation methods, various indices, micro stepping, applications. Servo systems – AC and DC servomotors, principle, characteristics, comparison, applications in automation and robotics.	9
III	**Reluctance Motors in Drives**: Synchronous Reluctance Motors – construction, principle, torque, characteristics, applications. Switched Reluctance Motors – construction, principle, torque-speed characteristics, power converter circuits (overview), rotor position sensing, advantages and limitations, control concepts in industrial and EV drive systems.	10

IV	**Single-Phase Motors in Appliances**: Universal motors– construction- compensated and uncompensated types, principle, speed control, characteristics, applications in domestic and industrial appliances. AC series motors, Repulsion motor and Hysteresis motors – construction, principle, phasor diagram, applications.	**8**
V	**Linear Motion Systems**: Linear induction motors – operating principle, thrust equation, equivalent circuit, thrust-speed characteristics, end effect and transverse edge effect, applications. Linear synchronous motor and Linear levitation machines – basic concept and applications.	**8**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46B	COMPUTER AIDED ELECTRICAL SYSTEM DESIGN	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces students to the principles and practices of electrical system design using computer-aided tools. Emphasis is placed on the design and analysis of low-voltage and medium-voltage electrical distribution systems in residential, commercial, and industrial installations through the use of modern software tools.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the standards and regulations used in the design of components for medium and high voltage installations.	Understand
CO2	Develop the lighting schemes for indoor and outdoor lighting systems.	Apply
CO3	Develop electrical schematic for low/medium voltage domestic electrical installations and select suitable protective devices.	Apply
CO4	Develop the single line diagram of 11kV indoor and outdoor transformer substations with light and power loads in an industry	Apply
CO5	Make use of short circuit calculations to design the earthing system for a 11kV substation.	Apply

iii) SYLLABUS

General awareness of IS Codes, The Electricity Act 2003- National Electric Code– Scope. Graphical symbols- Pre-commissioning tests of domestic installations

Lighting design calculations - Design of illumination systems - Average lumen method- Design of lighting systems for a medium area seminar hall using LED luminaires - LLF, CoU

Exterior lighting design - selection of luminaires - Familiarization of DIALux

Design of electrical installation in domestic buildings – connected load calculation, sub circuit determination – electrical schematic diagram. Introduction to AutoCAD

Design of distribution systems with light power and motor loads for small and medium industries. Design of MSB & SSB including Motor Control Centre (MCC) for motor controls - Design of indoor and outdoor 11kV substations up to 500kVA

Short circuit calculations: Short circuit calculations and earthing design for the HV and LV sides of a 11kV substation - Application of AI for Electrical design

iv) (a) TEXT BOOKS

1) S. K. Bhattacharya, K. B. Raina, *Electrical Design Estimating and Costing*, New Age International Publishers 2nd edition, 2017
2) M. K. Giridharan, *Electrical Systems Design*, I K International Publishers, New Delhi, 2nd edition, 2016.
3) Theodore R Bosela, *Electrical Systems Design*, Prentice Hall, 1st edition, 2002.
4) J.B. Gupta, *Course in Electrical Installation Estimating & Costing*, S. K. Kataria & Sons. 9th edition, 2012.
5) Steven J. Marrano, *Electrical System Design and Specification Handbook for Industrial Facilities*, Fairmont Press, 1998

(b) REFERENCES

1) U.A.Bakshi, V.U.Bakshi, *Electrical Technology*, Technical publications, Pune, 1st Edition, 2020.
2) S. C. Bloch, *Excel for Engineers and Scientists,* Wiley edition, 1st edition, 2000
3) *Electrical Installation Design Guide: Calculations for Electricians and Designers*, The Institution of Engineering and Technology (IET), 5th edition, 2022
4) IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
5) V. K. Jain & Amitabh Bajaj, *Design of Electrical Installations*, Lakshmi Publications Pvt. Ltd., 2nd edition 2012.
6) Kevin Warwick, Arthur Ekwue, Raj Aggarwal, *Artificial Intelligence Techniques in Power Systems,* IET, reprint 2008
7) https://www.dialux.com

v) COURSE PLAN

Module	Contents	No. of hours
I	**General awareness of IS Codes:** IS 732 - IS 3043 IS 2026- IS 3646- part 1&2 - IS 5216 part 1&2 - The Electricity Act 2003- National Electric Code (NEC 2011) – Scope. Graphical symbols as per NEC for electrical installations. Supply systems – single phase and three phase supply for residences. Voltage tolerance. Electrical design requirements for single-storey and multi-storey dwellings. Pre-commissioning tests in domestic installations.	**8**
II	**Lighting design calculations** - Luminous flux, Lumen, Luminous intensity, illuminance - Coefficients of Utilisation (CoU), Light Loss Factor (LLF). Design of indoor lighting system- Average lumen method - Space to mounting height ratio - Design of lighting systems for a medium area seminar hall using LED luminaires Exterior lighting design- point to point method - road lighting design - selection of luminaires – Area lighting Familiarization of DIALux software for interior lighting design- case study using DIALux	**9**
III	**Design of electrical installation in domestic buildings:** General aspects of the design of electrical installations for domestic dwellings- (single phase and three phase) - connected load calculation, sub circuit	**10**

	determination, selection of main distribution board, sub distribution board, MCB, ELCB, MCCB and cables for sub circuits. Electrical schematic layout **Familiarization of AutoCAD-** familiarization of basic tool set.	
IV	**Design of Industrial Installations:** Industry classification - Industrial loads - motors, starting of motors - Introduction to PCC, MCC panels- Motor wiring diagram. Design of distribution systems with light power and motor loads for small and medium industries. - Selection of transformer substations, switchgears and protective devices **Substations:** Classification – components of indoor and outdoor substations- single line diagram - Design of indoor and outdoor 11kV substations up to 500kVA.	**10**
V	**Short circuit calculations:** Short circuit calculations and earthing design for the HV and LV sides of a 11kV substation Touch, Step and Transfer potentials at EHT Sub-Stations, Earth-mat **Application of AI for Electrical design** - Fault detection in transformers, motors, and cables using AI- Load forecasting using AI (concepts only)	**8**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46C	POWER QUALITY	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course offers an introduction to the key concepts of power quality in electrical systems. This course covers different power quality issues and its mitigation methods. It also gives insights about techniques and technologies used for monitoring and mitigating these problems.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Classify the sources and effects of power quality problems.	Understand
CO2	Summarize the mechanism of harmonic generation.	Understand
CO3	Explain the important aspects of power quality monitoring.	Understand
CO4	Illustrate power quality mitigation techniques.	Understand
CO5	Explain power quality issues in grid connected renewable energy systems and the need for grounding and wiring.	Understand

iii) SYLLABUS

Power quality phenomenon, Sources and effects of power quality problems, classification and origin of power quality disturbances. Harmonics mechanism of harmonic generation, Harmonic sources, Harmonic analysis using Fourier series and Fourier transforms. Harmonic indices, Power quality Monitoring Mitigation of Power quality problems, passive filters, active filters, hybrid filters, DVR, DSTATCOM and UPQC.Power factor correction, Single phase active power factor converter, Power Quality issues of Grid connected Renewable Energy Systems, Grounding and wiring.

iv) (a) TEXT BOOKS

1) R. C. Dugan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill, 2012.
2) C. Sankaran, “Power Quality”, CRC Press, 2002.
3) G. T. Heydt, “Power Quality”, Stars in circle publication, Indiana, 1991.
4) Jose Arillaga, Neville R. Watson, “Power System Harmonics”, Wiley, 1997.
5) Math H. Bollen, ‘Understanding Power Quality Problems’ Wiley-IEEE Press, 1999.
6) Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, “Power Quality problems and Mitigation Techniques”, John Wiley and Sons Ltd, 2015.

(b) REFERENCES

1) Surajit Chattopadhyay, ‘Electric power quality’ – Springer, 2011
2) Angelo Baggini (Ed.) Handbook of Power Quality, Wiley, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Power quality** - Sources and effects of power quality problems, Need for concern of Power quality, types of power quality disturbances – Transients – classification and origin, Short duration voltage variation – interruption, sag, swell, Long duration voltage variation, voltage unbalance, waveform distortion - notching, harmonics and voltage flicker.	9
II	**Harmonics** - mechanism of harmonic generation, Triplen harmonics, Harmonic sources – switching devices, arcing devices and saturable devices, Effects of harmonics on power system equipment and loads – transformers, capacitor banks, motors and telecommunication systems, Effect of triplen harmonics on neutral current, line and phase voltages.	9
III	**Harmonic indices**: CF, DF, THD, TDD, TIF, DIN, C – message weights, Displacement and total power factor. **Standards**: Overview of power quality standards: IEEE 519, IEEE 1433 and IEC 61000. **Power quality Monitoring**: Objectives and measurement issues, different monitoring instruments – Power quality analyzer, harmonic spectrum analyzer, flicker meters. Case study using power quality analyzer	9
IV	**Mitigation of Power quality problems** - Harmonic elimination - Design simple problems and analysis of passive filters to reduce harmonic distortion – demerits of passive filters –description of active filters - shunt, series, hybrid filters, sag and swell correction using DVR. **Power quality conditioners** - DSTATCOM and UPQC - Configuration and working.	9
V	**Power factor correction** – Single phase active power factor converter – circuit schematic and control block diagram. Power Quality issues of Grid connected Renewable Energy Systems – operating conflicts. **Grounding and wiring**– reasons for grounding – wiring and grounding problems - solutions to these problems.	9
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks

Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46D	DIGITAL CONTROL SYSTEMS	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course aims to provide a strong foundation in discrete domain modelling, analysis and design of digital controllers to meet performance requirements.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the various control blocks and components of digital control systems. Mathematical modeling of ZOH and FOH	Apply
CO2	Make use of z-domain techniques to analyse sampled data systems	Apply
CO3	Design a digital controller/ compensator in the frequency domain.	Apply
CO4	Design a digital controller/ compensator in the time domain.	Apply
CO5	Develop controllers for linear discrete time systems using state variable concepts.	Apply

iii) SYLLABUS

Basic digital control system - Mathematical modeling - sampling and reconstruction -Zero order and First order hold circuits - realization of digital filters. Relation between transfer function and pulse transfer function - Mapping between s-domain and z-domain. Pulse transfer function of different configurations of systems - Modified z-transform –Time Response of discrete time system. Design of controller/Compensator in frequency domain - Bilinear transformation and sketching of frequency response. Introduction to design and simulation using MATLAB. Design of controller/Compensator based on time response, Introduction to Dead beat response and deadbeat controller design. Modern control approach to digital control - Introduction to state space - Computation of solution of state equation and state transition matrix. Controllability, observability and stability of discrete time systems. Digital controller and observer design.

iv) (a) TEXT BOOKS

1) C. L. Philips, H. T. Nagle, “Digital Control Systems”, Prentice-Hall, 3rd edition, 1995
2) M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill, 4th edition, 2017.
3) Ogata K., Discrete-Time Control Systems, Pearson Education, 2nd edition, 2015.
4) Gene F. Franklin, J. David Powell, Michael Workman, Digital Control of Dynamic Systems, 3rd edition, Pearson, 1997.

(b) REFERENCES

1) Benjamin C. Kuo, Digital Control Systems, Oxford University Press, 2nd edition, 2007
2) Liegh J. R., Applied Digital Control, Dover Publications Inc., 2nd edition, 2006

3) C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw-Hill Inc.,US, 2nd edition, 1992
4) V. I. George, C.P. Kurian, Digital Control Systems, Cengage Learning, 1st edition, 2012
5) Kavita Singh, Rashmi Vashisth, Digital Control System, Galgotia Publications, 2012

v) COURSE PLAN

Module	Contents	No. of hours
I	Basic digital control system- Mathematical modeling - sampling and reconstruction - Zero order and First order hold circuits - realization of digital filters. Relation between transfer function and pulse transfer function - Mapping between s-domain and z-domain.	**9**
II	Pulse transfer function of different configurations of systems- Modified z-transform-Time Response of discrete time system. Order and Type of a system Steady state error and Static error constants. Matlab Simulation of simple digital control systems for time domain analysis.	**8**
III	Bilinear transformation and sketching of frequency response - Digital P/PI/PID controller design based on frequency response – Digital compensator based on frequency response. Introduction to design and simulation using MATLAB (for demo/ assignment only and not to be included for examination).	**10**
IV	Design of lag and lead compensator using root locus – - Digital P/PI/PID controller design based on root locus- Dead beat response controller introduction only. Matlab Simulation.	**8**
V	Introduction to state space - state space modeling of discrete time SISO system - Computation of solution of state equation and state transition matrix. Controllability, observability and stabilizability of discrete time systems- Loss of controllability and observability due to sampling	**10**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46E	VEHICULAR NETWORKS AND COMMUNICATION	PEC	3	0	0	0	3	2023

i) **COURSE OVERVIEW**: This course designed to explore the principles and practices related to communication systems and networking in vehicular environments. The course focuses on the underlying technologies, protocols, and real-time applications that are shaping the future of vehicular communication, with a strong emphasis on Intelligent Transportation Systems (ITS), V2V (Vehicle-to-Vehicle), V2I (Vehicle-to-Infrastructure).

ii) **COURSE OUTCOMES**

After the completion of the course, the student will be able to:

CO1	Explain the architecture, types, and applications of vehicular networks.	Understand
CO2	Summarize the communication technologies and standards used in vehicular networks.	Understand
CO3	Summarize the vehicle networking protocols, automotive functional safety, and cybersecurity frameworks.	Understand
CO4	Explain the performance of vehicular networks using various metrics.	Understand
CO5	Interpret the emerging applications and future trends in vehicular networks.	Understand

iii) **SYLLABUS**

Introduction to Vehicular Networks: Overview of Vehicular Networks (VN) and types. Architecture and key applications in Intelligent Transportation Systems (ITS). Challenges: High mobility, communication range, and safety concerns.

Communication Technologies for Vehicular Networks: Key technologies, V2V role in safety, V2I in urban planning, and traffic management. Emerging 5G NR standards and communication protocols.

Network Protocols and Security in Vehicular Communication: Key communication protocols, Routing protocols for V2V and V2I. Security issues.

Performance Analysis of Vehicular Networks: Performance metrics. Simulation tools: NS3, OMNeT++. Real-time analysis: Urban and highway scenarios, interference management, and QoS in vehicular communication.

Applications and Future Trends: Advanced applications: Autonomous vehicles, traffic monitoring, emergency response. Real-time data sharing and decision-making. Role of AI and ML in vehicular networks. Future of 5G and beyond, integration with smart cities, and urban mobility solutions.

iv) **(a) TEXT BOOKS**

1) C. E. Lee, *Introduction to Vehicular Networking and Communication*, Elsevier, 2019.
2) X. Lin, *Vehicular Communication Systems: Protocols, Standards, and Applications*, Wiley-IEEE Press, 2020.

3) H. Hartenstein, *Security and Privacy in Vehicular Networks*, Springer, 2019.
4) T. G. Dietterich, *Analysis of Vehicular Ad Hoc Networks: Tools, Methods, and Case Studies*, Wiley, 2018.
5) M. Alam, *Advanced Vehicular Communications: Technologies and Applications*, Springer, 2022.
6) Xiao Zhang & Tao Han, *Multi-Access Edge Computing for Vehicular Networks*, Springer, 2021.
7) L. Reimer & J. Kuusela, *Software-Defined Vehicles: Architecture and Systems*, SAE International, 2023.

(b) REFERENCES

1) R. H. Weber, *The Internet of Things: Legal Perspectives*, Springer, 2010.
2) H. Hartenstein, *Vehicular Ad Hoc Networks: Architectures, Protocols, and Applications*, Springer, 2016.
3) F. B. Bastani, *Network Protocols in Vehicular Ad Hoc Networks*, Elsevier, 2017.
4) Z. Zeng, *Vehicular Security and Privacy: Advances and Challenges*, Wiley, 2021.
5) J. S. L. H. Venkatesh, *Performance Analysis and Optimization of Vehicular Networks*, Springer, 2020.
6) S. M. Balamurugan, *Autonomous Vehicles and Future Trends*, Elsevier, 2021.
7) P. H. J. P. Weijun, *Smart Mobility and Connected Vehicles*, Wiley, 2023.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Vehicular Networks:** Overview of Vehicular Networks (VN). Types of Vehicular Networks: V2V, V2I, V2X Architecture of Vehicular Networks. Applications of Vehicular Networks in Intelligent Transportation Systems (ITS) Challenges in Vehicular Networking: High mobility, Communication range, and Safety issues. Software-Defined Vehicles (SDV): architecture, virtualization of vehicle functions.	**9**
II	**Communication Technologies for Vehicular Networks:** Basics of Communication Technologies: DSRC, Wi-Fi, 5G, and LTE. Emerging communication standards: 5G NR (New Radio) for vehicular communication. Communication protocols: IEEE 802.11p, Cellular V2X (C-V2X) Role of V2V Communication in Vehicular Safety. Role of V2I Communication in Urban Planning and Traffic Management.	**9**
III	**Network Protocols and Security in Vehicular Communication:** Communication Protocols in Vehicular Networks: Medium Access Control (MAC), Transport Layer Protocols, Routing Protocols for V2V and V2I communications. Security Issues in Vehicular Networks: Authentication and Authorization, Secure Communication and Data Privacy, Vulnerabilities and Attack Mitigation.	**9**

	Cybersecurity frameworks: ISO/SAE 21434, UNECE WP.29 regulations (R155 & R156).	
IV	**Performance Analysis of Vehicular Networks:** Metrics for Performance Evaluation: Throughput, Latency, Packet Delivery Ratio (PDR) Simulation Tools for Vehicular Networks: NS-3, OMNeT++ Real-time Performance Analysis in Urban and Highway Scenarios Interference Management and Quality of Service (QoS) in Vehicular Communication. Impact of Mobility on Network Performance.	**9**
V	**Applications and Future Trends: Advanced Applications:** Autonomous Vehicles, Traffic Monitoring, Emergency Response. Real-time Data Sharing and Decision Making in Vehicular Networks. Role of AI and Machine Learning in Vehicular Networks. Smart city integration: roadside edge nodes, digital twins, fleet-wide vehicle analytics 5G and Beyond: The Future of Vehicular Networks. Integration with Smart Cities and Urban Mobility Solutions	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46F	SOFTWARE TESTING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course introduces the principles and methods of software testing within the domain of theoretical computer science. It covers systematic techniques for test case design used in testing software artifacts such as requirements, design, and source code. The course includes test design approaches based on graphs, programming language syntax, and symbolic execution using the PEX tool. It equips learners with structured and methodical software testing practices to be applied during application development.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the fundamental concepts of software testing, including the need for testing, testing processes, key terminologies, types of testing, and testing methods	Understand
CO2	Outline unit testing concepts, including static and dynamic testing methods, and basics of mutation testing.	Understand
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program	Understand
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing	Understand
CO5	Demonstrate grey box testing concepts, its advantages and disadvantages, and various testing techniques	Understand
CO6	Apply JUnit and MuClipse for mutation testing, graph-based testing, and black-box testing, and utilize PEX for symbolic execution through case studies.	Apply

iii) SYLLABUS

Popular software failures and the importance of software testing and software quality; testing fundamentals including roles, processes, levels of thinking, and key terminologies; levels, types, and methods of testing including unit, integration, system, acceptance, regression, black box, white box, and grey box testing; unit testing concepts including static and dynamic testing, control flow and data flow testing; mutation testing and graph-based testing with coverage criteria; domain testing and functional testing techniques such as equivalence class partitioning and boundary value analysis; grey box testing strategies and testing tools; case studies using JUnit; and an introduction to parameterized unit testing, symbolic execution, and PEX.

iv) (a) TEXT BOOKS

1) Paul Ammann and Jeff Offutt, *Introduction to Software Testing*, Cambridge University Press, 2nd edition, 2016.
2) Kshirasagar Naik and Priyadarshi Tripathy, Software Testing and Quality Assurance: Theory and Practice, Wiley, 1st edition, 2008
3) Srinivasan Desikan & Gopalaswamy Ramesh, Software Testing: Principles and Practice, Pearson Education, 1st edition, 2006
4) Dorothy Graham, Erik van Veenendaal, Isabel Evans, and Rex Black, Foundations of Software Testing, Cengage Learning, 4th edition, 2019
5) Yogesh Singh, Software Testing, Cambridge University Press, First Edition, 2011, ISBN: 9781107012967 (Print), 9781139534239 (eBook)

(b) REFERENCES

1) Nancy G. Leveson, Engineering - A Safer World: Systems Thinking Applied to Safety, MIT Press, 1st edition, 2011
2) https://muclipse.sourceforge.net/docs/muclipsebinder.pdf
3) https://www.microsoft.com/en-us/research/wp-content/uploads/2016/08/deep_dive_into_pex_for_code_hunt.pdf

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Software Testing: Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. Concept of Software testing, need for software testing. Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.	9
	Concept of Unit Testing. Static Unit Testing. Dynamic Unit Testing –	

II	Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Test drivers and stubs. Code coverage metrics – statement and branch coverage. Mutation testing – Mutation and Mutants, Mutation operators, Mutation score. JUnit – Framework for Unit testing and assertions. Case Study – Mutation testing using JUnit and MuClipse.	**9**
III	Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.	**9**
IV	Domain Testing / Input Space Partitioning – partitions of a set, input domain modelling using interface-based and functionality-based approaches, identifying values. Multiple partitions of the input domain – Each Choice Coverage, Pair-wise Coverage, Base Choice Coverage (overview of ACoC, T-wise, and Multiple Base Choices). TriTyp example. Functional Testing – concepts of Howden, important steps, and black-box techniques including Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, and Random Testing (overview). Case Study – Black-box testing approaches using JUnit.	**9**
V	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)

- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46G	BLOCKCHAIN TECHNOLOGIES	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course aims to build awareness and a foundational understanding of blockchain technology among students. It introduces the cryptographic principles underlying blockchain and helps students comprehend key concepts such as consensus mechanisms, cryptocurrency, smart contracts, and real-world use cases. The course also equips students with the skills to develop simple decentralized applications using blockchain networks like Ethereum.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the fundamental concepts of cryptocurrency and the way cryptographic techniques ensure secure transactions.	Understand
CO2	Demonstrate the structure and workflow of public blockchains such as Bitcoin.	Understand
CO3	Explain the concept and working of smart contracts using Solidity.	Understand
CO4	Explain the features and architecture of enterprise blockchains like Hyperledger Fabric.	Understand
CO5	Explain blockchain applications in the energy sector and industry, along with key challenges and emerging trends.	Understand
CO6	Apply blockchain concepts to analyze real-world use cases considering security, scalability, and regulatory issues.	Apply

iii) SYLLABUS

Introduction to Cryptography. Symmetric and Asymmetric Encryption. Digital Signatures and Hashing Algorithms. Blockchain Architecture and Components. Types of Blockchain: Public, Private, Consortium. Distributed Ledger Technology and Decentralization. Consensus Mechanisms: PoW, PoS, PBFT, Raft. Bitcoin: Transactions, Wallets, Mining. Ethereum: Architecture, Smart Contracts, Gas. Solidity Programming: Variables, Functions, Inheritance. Smart Contract Deployment and Use Cases. Blockchain in Energy Systems, Supply Chain, and Governance. Integration with IoT, Cloud, and AI. Overview of Hyperledger and Enterprise Blockchain Platforms.

iv) (a) TEXT BOOKS

1) Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.
2) Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and

Applications, First Edition, Wiley Publications, First edition, 2020.

(b) REFERENCES

1) Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing, First edition, 2018.
2) Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020.
3) Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.
4) Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.
5) Andreas M. Antonopoulos, David A. Harding, Mastering Bitcoin: Programming the Open Blockchain, O'Reilly Media, Third edition, 2023.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Foundations of Cryptography and Blockchain:** Introduction to cryptography. Symmetric and asymmetric cryptography. Digital signatures and RSA. Hashing and Merkle trees. Blockchain definition and architecture. Key features: immutability, decentralization, transparency. Distributed ledger vs. traditional database. Components and types of blockchain – public, private, consortium. Blockchain benefits and limitations.	9
II	**Consensus Mechanisms and Bitcoin Ecosystem Consensus mechanisms:** Consensus Algorithms- PoW, PoS, PBFT, Paxos, Raft. Bitcoin architecture and working. Cryptography in Bitcoin: Public and private keys, addresses. Transactions, coinbase, validation process. Bitcoin mining – tasks, algorithms, hash rate. Wallets and transaction lifecycle. Limitations and security threats in Bitcoin.	9
III	**Ethereum and Smart Contracts:** Ethereum ecosystem and architecture. Ether and Gas. Ethereum Virtual Machine (EVM). Smart contracts – definition, templates, oracles. Solidity Programming: Basics: variables, functions, control structures. Events, error handling, inheritance. Advanced features: Case studies: voting system, auction smart contracts. Maintenance: Debugging and optimization.	9
IV	**Enterprise Blockchain:** Hyperledger and MultiChain, Hyperledger Fabric – architecture, peers, chaincode, channels. Smart contract deployment using Composer. MultiChain platform – features, permission models, command-line usage. Blockchain-as-a-Service (BaaS). Permissioned vs permissionless blockchains. Comparison of public and enterprise frameworks.	9

V	**Applications of Blockchain:** Energy Sector**-** Use cases in smart grid, energy trading, power system automation. Industry Applications- Blockchain in healthcare, supply chain, identity verification (Aadhaar), capital markets. Blockchain with IoT. Blockchain integration with AI and cloud. Issues & Future -Security, scalability, and regulatory challenges. Emerging trends and career paths.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL46H	DATA MINING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW: This course helps to understand the concepts of data mining and data warehousing. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basic concepts, architecture, and functionalities of data warehousing and data mining.	Understand
CO2	Explain various preprocessing techniques to convert raw data into suitable format for practical data mining tasks.	Understand
CO3	Apply classification and clustering algorithms to organize and group data effectively.	Apply
CO4	Apply association rule mining algorithms to extract patterns from transactional data.	Apply
CO5	Explain advanced data mining concepts and their applications in emerging domains.	Understand

iii) SYLLABUS

Introduction to data mining and data warehousing-Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values-Classification- Introduction, Decision tree construction principle, Splitting indices-Introduction to clustering-Clustering Paradigms, Partitioning Algorithm-Association Rule Analysis- Association Rules-Introduction, Methods to discover Association rules, Apriori (Level wise algorithm),Advanced Data Mining Techniques-Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining.

iv) (a) TEXTBOOKS

1) Dunham M H, Data Mining: Introductory and Advanced Topics, Pearson Education, New Delhi, 2003.
2) Arun K Pujari, Data Mining Techniques, Universities Press Private Limited, 2008.
3) Jaiwei Han and Micheline Kamber, Data Mining Concepts and Techniques, Elsevier, 2006.

b) REFERENCES

1) M Sudeep Elayidom, Data Mining and Warehousing, 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2) MehmedKantardzic, Data Mining Concepts, Methods and Algorithms, John Wiley and Sons, USA, 2003.
3) Pang-Ning Tan and Michael Steinbach, Introduction to Data Mining, Addison Wesley, 2006.

v) COURSE PLAN

Module	Contents	No. of hours
I	Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse – Definition, Features, and Applications, Differences between Operational Database Systems and Data Warehouses, Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools-Multidimensional Data Model, Data Warehouse Schema: Star, Snowflake, and Fact Constellation. OLAP Operations: Roll-up, Drilldown, Slice, Dice, Pivot- Data Mining: - Data Mining Functionalities.	**9**
II	Data Preprocessing Techniques -Need of data preprocessing, Data Cleaning- Handling missing values and noisy data, Data Integration and Transformation, Data Reduction techniques -Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction. Data Discretization and generation of concept hierarchies.	**9**
III	Classification- Introduction, Decision tree construction principle, Splitting indices -Information Gain, Gini index, Decision tree construction algorithms-ID3, Decision tree construction with presorting-SLIQ, Classification Accuracy-Precision, Recall. Introduction to clustering-Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK. Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.	**9**
IV	Association Rule Analysis-Association Rules-Introduction, Methods to discover Association rules, Apriori (Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.	**9**

V	Advanced Data Mining Techniques-Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining Preprocessing, Data structures, Pattern Discovery, Pattern Analysis. Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques, Query Processing Techniques.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- Two tests of **30 marks each** (2 ½ modules to be covered in each exam)
- Duration – 1.5 hours

viii) END SEMESTER EXAMINATION PATTERN

- Two parts - Part A and Part B – with a total of **60 marks**
- Part A contains compulsory questions. Part B contains choice questions.
- Duration – **3 hours**

MINORS/HONOURS

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELJ4HB/23ELJ4HD/ 23ELJ4HF	MINIPROJECT	VAC	0	0	6	0	3	2023

i) COURSE OVERVIEW:

The main objective of this course is to apply fundamental concepts learned in the respective Honour streams of Engineering through practical implementation. The course provides students with exposure to the development of application-oriented software, hardware solutions, or software simulations in their chosen field. Working in small teams under faculty supervision, students identify a relevant problem, perform literature review, plan and execute the project, and present the outcomes through a working model or prototype. The mini project enhances problem-solving ability, teamwork, project planning, and technical communication skills, and serves as a foundation for future research or major project work.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to

CO1	Identify engineering problems that are socially relevant, technically feasible, and economically viable.	Apply
CO2	Make use of relevant literature and existing engineering principles to explore and analyze potential solutions.	Apply
CO3	Develop a suitable design or methodology using modern tools while adhering to professional ethics.	Apply
CO4	Evaluate the performance or feasibility of the proposed solution using theoretical or experimental validation.	Evaluate
CO5	Apply effective communication techniques to prepare technical reports, presentations, and demonstrations.	Apply
CO 6	Plan and execute project activities and coordinate effectively within a team to meet objectives and deadlines.	Apply

iii) COURSE PLAN / GUIDELINES:

In this course, each group consisting of a maximum of 4 members is expected to design and develop a moderately complex software/hardware system relevant to their domain with practical applications. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with the Project guide assigned and Project coordinator in charge of the course. They should review the literature from latest journals, relevant conferences and gather information pertaining to the chosen topic. Later the group should state the objectives and develop a methodology to achieve the objectives and then carry out the design/fabrication or develop codes/programs to achieve the objectives. Finally the team should demonstrate the novelty of the project through the working results and outputs. The progress of the

mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department/Project Coordinator in charge. A project report is required at the end of the semester which will be evaluated and approved by the department. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due considerations. A zeroth review may be conducted to finalize the topic and plan in the beginning. Two continuous reviews will assess progress and implementation.

iv) EVALUATION SCHEME

The Mini Project shall be evaluated through a comprehensive assessment framework designed to monitor continuous progress, technical competence, and quality of documentation. The evaluation carries a total of 100 marks, with a minimum pass requirement of 50 marks, and is conducted through multiple stages involving the project guide and an evaluation committee. Continuous assessment includes project progress evaluation by the guide, two interim evaluations by the Evaluation Committee to assess problem formulation, design, and implementation progress, and a final evaluation to judge the level of completion, functionality, demonstration, technical understanding, and viva-voce performance. In addition, the quality of the project report is assessed for technical depth, clarity, organization, and adherence to prescribed standards. The Evaluation Committee comprises the Head of the Department or a senior faculty member, the Mini Project Coordinator, and the Project Supervisor, ensuring a fair and holistic evaluation of the mini project.

v) EVALUATION PATTERN AND MARK DISTRIBUTION

Project progress evaluation by Guide	: 20 marks
Interim Evaluation – I	: 15 marks
Interim Evaluation – II	: 15 marks
Final Evaluation by Evaluation Committee: 30 marks	
Quality of Project Report: 20 marks	
Total	: **100 marks**