CURRICULUM
&
SYLLABUS
2020 Scheme
(Revised in 2022)
(Autonomous)
Version 1.0

B.TECH
ELECTRICAL AND ELECTRONICS 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 ELECTRONICS ENGINEERING

SEMESTERS VII & VIII

2020 SCHEME (REVISED IN 2022)

(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 ELECTRONICS ENGINEERING

FOURTH YEAR SYLLABUS

2020 SCHEME (REVISED IN 2022)

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	30.04.2025	28.05.2025

Head of Department
Chairman, Board of Studies

MAR BASELIOS COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS) ★ MAR IVANIOS VIDYANAGAR THIRUVANANTHAPURAM PIN: 695015

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

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.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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)

PEO1: Graduates will succeed as Professionals in Industry or as Entrepreneurs in Electrical and Electronics Engineering and related disciplines.

PEO2: Graduates will be able to adapt to the advances in Technology by continuously acquiring knowledge and skills, with an urge for innovation.

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

PROGRAMME OUTCOMES (POs)

Engineering Graduates will have the ability 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:

1. To apply the knowledge in Electrical and Electronics Engineering for the design of Power Generation, Transmission, Distribution and Utilization systems.
2. To demonstrate the knowledge required to design, develop, test, and implement Electrical & Electronic systems.

CURRICULUM

SEMESTER VII						
Slot	**Cate-gory**	**Course Code**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EE1U40D	Power Systems II	3-1-0	4	4
B	PEC	EE1UXXX	Program Elective III	3-0-0/ 2-1-0	3	3
C	OEC	EE0UXXX	Open Elective II	3-0-0/ 2-1-0	3	3
D	MNC	NC0U40A	Industrial Safety Engineering	2-1-0	3	---
S	PCC	EE1U48B	Power Systems Lab	0-0-3	3	2
T	PWS	EE1U49A	Seminar	0-0-3	3	2
U	PWS	EE1U49B	Project Phase I	0-0-6	6	2
R/M/H	VAC		Remedial/Minor/Honours Course	0-1-6/ 4-0-0	7/4	4
TOTAL					**25/ (32/29)**	**16/20**

PROGRAM ELECTIVE III

Slot	**Cate gory**	**Course Code**	**Course**	**L-T-P**	**Hours**	**Credit**
B	PEC	EE1U41Z	Fundamentals of Robotics	2-1-0	3	3
		EE1U41Y	Electrical System Design for Domestic Dwellings	2-1-0	3	3
		EE1U41X	Distributed Generation and Smart Grids	3-0-0	3	3
		EE1U41W	Special Electrical Machines	3-0-0	3	3
		EE1U41V	Emerging Technologies in Sports	3-0-0	3	3
		EE1U41U	Power System Protection	3-0-0	3	3
		EE1U41D	Data Structures	2-1-0	3	3

OPEN ELECTIVE II

Slot	**Cate gory**	**Course Code**	**Course**	**L-T-P**	**Hours**	**Credit**
C	OEC	EE0U41Z	Architectural Lighting Design and Control	2-1-0	3	3
		EE0U41Y	Electric Vehicles	3-0-0	3	3
		EE0U41X	Process Control and Automation	3-0-0	3	3
		EE0U41W	Sustainable Energy Management	3-0-0	3	3

MINORS

Slot	Category	Course Code	Courses	L-T-P	Credit
R/M/H	VAC	EE0M49A	Mini Project	0-1-6	4

HONOURS

Slot	Category	Course Code	Courses	L-T-P	Credit
R/M/H	VAC	EE1H40A	Operation and Control of Generators	4-0-0	4
		EE1H40B	Dynamics of Power Converters	3-1-0	4
		EE1H40C	Control and Dynamics of Microgrids	4-0-0	4

SEMESTER VIII

Slot	Category	Course Code	Courses	L-T-P	Hours	Credit
A	PEC	EE1UXXX	Program Elective IV	3-0-0	3	3
B	PEC	EE1UXXX	Program Elective V	3-0-0	3	3
C	PEC	EE1UXXX	Program Elective VI	3-0-0	3	3
D	HSC	HS0U40A	Industrial Economics & Foreign Trade	3-0-0	3	3
T	PCC	EE1U40E	Comprehensive Course Viva	1-0-0	1	1
U	PWS	EE1U49C	Project Phase II	0-0-12	12	4
R/M/H	VAC		Remedial/Minor/Honours Course	0-1-6	7	4
				TOTAL	**25/32**	**17/21**

PROGRAM ELECTIVE IV

Slot	Category	Course Code	Course	L-T-P	Hours	Credit
A	PEC	EE1U42Z	Communication Engineering	3-0-0	3	3
		EE1U42Y	Internet of Things	3-0-0	3	3
		EE1U42X	Power Quality	3-0-0	3	3
		EE1U42W	Computer Networks	3-0-0	3	3
		EE1U42V	Energy Management and Auditing	3-0-0	3	3
		EE1U42U	Automotive Electrical and Electronic Systems	3-0-0	3	3
		EE1U42T	Digital Control Systems	2-1-0	3	3

PROGRAM ELECTVE V

Slot	Category	Course Code	Course	L-T-P	Hours	Credit
B	PEC	EE1U43Z	Switched Mode Power Converters	3-0-0	3	3
		EE1U43Y	Industrial Instrumentation and Automation	3-0-0	3	3
		EE1U43X	VR and AR for Assistive Technology	3-0-0	3	3
		EE1U43W	Electrical System Design for Industry and Infrastructure	2-1-0	3	3
		EE1U43V	Computer Aided Power System Analysis	2-1-0	3	3
		EE1U43U	Fundamentals of Nanotechnology	3-0-0	3	3
		EE1U43T	Energy Storage Systems	3-0-0	3	3

PROGRAM ELECTIVE VI

Slot	Category	Course Code	Course	L-T-P	Hours	Credit
C	PEC	EE1U44A	Electric and Hybrid Vehicles	3-0-0	3	3
		EE1U44E	Solar PV Systems	2-1-0	3	3
		EE1U44Z	HVDC & FACTS	3-0-0	3	3
		EE1U44Y	Modern Control Techniques	2-1-0	3	3
		EE1U44X	High Voltage Engineering	3-0-0	3	3
		EE1U44G	Big Data Analytics	3-0-0	3	3
		EE1U44W	Digital Image Processing	3-0-0	3	3

MINORS

Slot	Category	Course Code	Courses	L-T-P	Credit
R/M/H	VAC	EE0M49B	Mini Project	0-1-6	4

HONOURS

Slot	Category	Course Code	Courses	L-T-P	Credit
R/M/H	VAC	EE1H49A	Mini Project	0-1-6	4

SYLLABUS

SEMESTER VII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U40D	POWER SYSTEMS II	PCC	3	1	0	4	2022

i) PRE-REQUISITE: EE1U30A Power Systems I.

ii) COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of Per unit systems, Fault calculations and Load flow analysis of electric power system. The course also intends to deliver the basic concepts of power system stability and Optimal scheduling of electric power Generation

iii) COURSE OUTCOMES

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

CO1	Apply the per unit scheme for any power system network and compute the fault levels.	Apply
CO2	Solve load flow problems of any given power system network using iterative methods.	Apply
CO3	Develop the block diagram representations of automatic generation control scheme of power systems.	Apply
CO4	Solve for the steady state limit and transient stability of power system networks.	Apply
CO5	Solve economic despatch problems of power system networks.	Apply

iv) SYLLABUS

Per unit quantities- Symmetrical components- sequence networks- Fault calculations- symmetrical fault- Unsymmetrical faults - Contingency ranking.
Load flow studies -network model formulation and admittance matrix, Gauss-Siedel (two iterations), Newton-Raphson and Fast Decoupled method (Qualitative analysis only)- principle of DC load flow
Automatic Generation Control: Load frequency control, single area and two area systems - Automatic Voltage Regulation - Exciter Control - SCADA systems
Power system stability - steady state, dynamic and transient stability-power angle curve-steady state stability limit -mechanics of angular motion-swing equation - solution of swing equation - Equal area criterion application - methods of improving stability.
Economic Operation - Distribution of load between units within a plant - penalty factors and loss coefficients. Unit commitment: Introduction — constraints on unit commitments: spinning reserve, thermal unit constraints- hydro constraints.

v) (a) TEXT BOOKS

1) Hadi Saadat, *Power System Analysis*, 2/e, McGraw Hill, 2002.
2) D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, 2/e, TMH, 2009.
3) Kundur P., *Power system Stability and Control*, McGraw Hill, 2006.
4) Allen J. Wood and Bruce F. Wollenberg., *Power Generation, Operation, and Control,* Wiley, 2nd Edition, 1996.

5) Cotton H. and H. Barbera, Transmission & Distribution of Electrical Energy, 3/e, Hodder and Stoughton, 1978.
6) Gupta B. R., *Power System Analysis and Design*, S. Chand, New Delhi, 2006.
7) Gupta J.B., Transmission *& Distribution of Electrical Power*, S.K. Kataria & Sons, 2009.
8) Soni, M.L., P. V. Gupta and U. S. Bhatnagar, *A Course in Electrical Power*, Dhanpat Rai& Sons, New Delhi, 1984.

(b) REFERENCES

1) John J Grainger and William D Stevenson, *Power System Analysis*, 4/e, McGraw Hill, 1994.
2) Uppal S. L. and S. Rao, *Electrical Power Systems*, Khanna Publishers, 2009.
3) Wadhwa C. L., *Electrical Power Systems*, 33/e, New Age International, 2004.
4) Weedy B. M., B. J. Cory, N. Jenkins, J. B. Ekanayake and G. Strbac, *Electric Power System*, John Wiley & Sons, 2012.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Per unit quantities-single phase and three phase - Symmetrical components - sequence networks - Fault calculations - symmetrical fault - Unsymmetrical faults - single line to ground, line to line, double line to ground faults.	**13**
II	Load flow studies – Introduction – types - network model formulation and admittance matrix, Gauss-Siedel (two iterations), Newton-Raphson and Fast Decoupled method (Qualitative analysis only) - principle of DC load flow.	**12**
III	Automatic Generation Control: Load frequency control, single area and two area systems - Droop characteristics - Automatic Voltage Regulation - SCADA systems.	**11**
IV	Power system stability - steady state, dynamic and transient stability-power angle curve-steady state stability limit - mechanics of angular motion-swing equation - solution of swing equation - Point by Point method - RK method - Equal area criterion application - methods of improving stability limits - Phasor Measurement Units - Wide Area Monitoring Systems.	**13**
V	Economic Operation - Distribution of load between units within a plant - transmission loss as a function of plant generation - distribution of load between plants - method of computing penalty factors and loss coefficients. Unit commitment: Introduction - constraints on unit commitments: spinning reserve, thermal unit constraints - hydro constraints. Power system standards: Overview of national and international standards (e.g., IEEE, IEC) applicable to power system planning, operation, and protection.	**11**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U40A	INDUSTRIAL SAFETY ENGINEERING	MNC	2	1	0	-	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: Objective of the course to impart knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context.

iii) COURSE OUTCOMES

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

CO1	Explain the theories of accident causation and preventive measures of industrial accidents.	Understand
CO2	Explain about personal protective equipments, its selection, safety performance, role of housekeeping and work permits in industry.	Understand
CO3	Explain different safety issues in construction industries.	Understand
CO4	Summarize various hazards associated with different machines and material handling.	Understand
CO5	Explain different hazard identification tools in industries with the knowledge of different types of chemical hazards.	Understand

iv) SYLLABUS

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management,

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. Hearing Conservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, Material Safety Data Sheets.

v) (a) TEXT BOOKS

1) R.K Jain, *Industrial Safety: Health and Environment management systems*, Khanna Publications, 2000.
2) Paul S V, *Safety management System and Documentation training Programme Handbook*, CBS Publication 2000.
3) Krishnan N.V, *Safety management in Industry*, JaiCO Publishing House, New Delhi, 1997.

(b) REFERENCES

1) AIChE/CCPS, *Guidelines for Hazard Evaluation Procedures*, (2nd Edition), Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York. 1992.
2) Alan Waring, *Safety management system*, Chapman & Hall, England, 1996.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety, organization- objectives, types, functions, Role of management, supervisors, workers, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.	**9**
II	Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces. Technology generation and development, technology generation, process, technology development, importance of technology generation and development	**9**
III	Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards	**9**

	and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	
IV	Machinery safeguard-Point-of-Operation, Principle of machine guarding-types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration-manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements- wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries	**9**
V	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U48B	POWER SYSTEMS LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: EE1U30A: Power Systems I

ii) COURSE OVERVIEW:

Objective of the course is to train the students to perform load flow studies, short circuit studies, stability studies and automatic generation control using software. This course also imparts practical knowledge in testing Ferranti effect in transmission line, testing various power system components as per the standards, plotting relay characteristics, improving power factor of induction motor and measuring earth electrode resistance.

iii) COURSE OUTCOMES

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

CO1	Make use of MiPower software to conduct load flow studies, short circuit studies and stability studies on a given power system network	Apply
CO2	Make use of MATLAB Simulink to perform AGC of single area and two area systems	Apply
CO3	Apply Ferranti effect test on a transmission line	Apply
CO4	Experiment with power system switchgear, cables, dielectric materials and relays as per standards	Apply
CO5	Select suitable capacitor bank to improve the power factor of an induction motor to a desired value	Apply
CO6	Utilise Earth megger to measure Earth electrode resistance of an earthing system	Apply

iv) SYLLABUS

Software Experiments: Load flow studies, short circuit studies, transient stability studies, AGC.

Hardware Experiments: High voltage testing, Ferranti effect, relay testing, insulation testing of cables, Measurement of Earth electrode resistance, testing of dielectric strength of different materials, power factor improvement of induction motor.

v) REFERENCES

1) Hadi Saadat, *Power System Analysis*, 2/e, McGraw Hill, 2002.
2) Kothari D. P. and I. J. Nagrath, *Modern Power System Analysis*, 4/e, TMH, 2011.
3) M. S. Naidu, V. Kamaraju, *High Voltage Engineering*, Tata McGraw-Hill Education, 2004.
4) Wadhwa C. L., *Electrical Power Systems*, 4/e, New Age International, 2017.
5) IEEE 1547 and 2030 Standards.
6) IS Codes for Testing of Power System components.

vi) COURSE PLAN

At least 12 experiments (6 hardware experiments are mandatory)

Expt No.	List of exercises/experiments	No. of hours
Part A: POWER SYSTEM SIMULATION EXPERIMENTS		
I	Load Flow Studies – Gauss-Siedel Method, Newton-Raphson Method, Fast Decoupled Method – Effect of change in load/generation schedule	**3**
II	Load Flow Studies – Gauss-Siedel Method, Newton-Raphson Method, Fast Decoupled Method – Effect of change in real power/reactive power limits	**3**
III	Short Circuit Studies – Symmetrical Faults	**3**
IV	Short Circuit Studies – Unsymmetrical Faults	**3**
V	Transient Stability Studies	**3**
VI	Automatic Generation Control – Single Area System	**3**
VII	Automatic Generation Control – Two Area System	**3**
Part B: POWER SYSTEM COMPONENT TESTING (Hardware experiments)		
I	Ferranti Effect and Reactive Power Compensation	**3**
II	High Voltage Testing – Power Frequency & Impulse	**3**
III	Relay Testing – Over Current Relay (Electromechanical & Static)	**3**
IV	Relay Testing – Under Voltage Relay (Electromechanical & Static)	**3**
V	Insulation Testing – LT & HT Cable	**3**
VI	Power Factor improvement of Induction Motor	**3**
VII	Measurement of Earth Electrode Resistance	**3**
VIII	Testing of Dielectric Strength of Transformer Oil	**3**
IX	Testing of Dielectric Strength of Solid Insulating Materials	**3**
X	Testing of Dielectric Strength of Air	**3**
	Total Hours	**45**

vii) CONTINUOUS INTERNAL EVALUATION (CIE) PATTERN

Attendance	:	15 marks
Regular Lab work	:	30 marks
Internal test	:	30 marks
Total	:	**75 marks**

viii) END SEMESTER EXAMINATION PATTERN

a)	Preliminary work	:	15 marks
b)	Implementing the work/Conducting the experiment	:	20 marks
c)	Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
d)	Viva voce	:	20 marks
e)	Record	:	5 marks
	Total	**:**	**75 marks**

ix) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U49A	SEMINAR	PWS	0	0	3	2	2022

i) COURSE OVERVIEW:

The Seminar course is designed to enhance the abilities of students in conducting literature surveys, staying informed about the latest advancements in their engineering discipline, preparing technical reports, and delivering effective presentations.

ii) COURSE OUTCOMES

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

CO1	Identify relevant academic documents from the literature related to their area of interest.	Apply
CO2	Examine and interpret academic documents from the literature in their area of interest.	Analyze
CO3	Develop a structured presentation based on an academic document.	Create
CO4	Demonstrate effective communication skills by delivering a presentation on an academic document.	Apply
CO5	Develop a well-structured technical report.	Create

iii) GUIDELINES

- The Department shall constitute an Internal Evaluation Committee (IEC) for the seminar, with the academic coordinator of the program serving as the Chairperson/Chairman and the seminar coordinator and seminar guide as members.
- All members of the IEC must be present during the seminar presentation of a student.
- The formation of the IEC and the allotment of guides shall be completed within one week after the End Semester Examination (or the last working day) of the previous semester.
- The guide shall provide necessary guidance to students regarding topic or paper selection.
- The seminar topic for undergraduate students should be current and broad-based rather than highly specific research work. The seminar topic should be closely related to the final-year project area. Each member of a project team may choose or be assigned seminar topics covering different aspects of the project area.
- Students shall select a topic or paper relevant to their discipline during the semester break.
- The selected topic or paper shall be finalized in the first week of the semester and submitted to the IEC.
- The IEC shall review and approve the selected topic or paper by the second week of the semester.
- The seminar report must include accurate references from credible, peer-reviewed published sources, which shall be verified.

iv) EVALUATION PATTERN

Total marks : 100 (only CIE)
Minimum marks required to pass : 50

Seminar Guide: 20 marks
(Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected),
Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks
(Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC
(Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC
(Check for technical content, overall quality, templates followed, adequacy of references etc.).

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U49B	PROJECT PHASE I	PWS	0	0	6	2	2022

i) PREAMBLE:

The course "Project Work" is mainly intended to evoke the innovation and invention skills in 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. The project extends to 2 semesters and will be evaluated in the 7th and 8th semesters separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. 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 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.

iii) COURSE OUTCOMES

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

CO1	Model and solve real world problems by applying knowledge across domains.	Apply
CO2	Develop products, processes or technologies for sustainable and socially relevant applications.	Apply
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks.	Apply
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.	Apply
CO5	Identify technology/research gaps and propose innovative/creative solutions.	Analyse
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms.	Apply

iv) GUIDELINES

1) Identify suitable projects relevant to the branch of study.
2) Form project team.
3) Identify a project supervisor.
4) In case of interdisciplinary projects, the faculty member(s) from the concerned department(s) are also the supervisor(s) for the students.

5) Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.
6) The preliminary work to be completed:
   a. Literature survey
   b. Formulation of objectives
   c. Formulation of hypothesis/design/methodology
   d. Formulation of work plan
   e. Seeking funds
   f. Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
   g. Preparation of Phase I report

Note: The same project should be continued in the eighth semester by the same project team.

v) ASSESSMENT PATTERN

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

- Project progress evaluation by guide : 30 Marks
- Interim evaluation by the Evaluation Committee : 20 Marks
- Final Evaluation by the Evaluation Committee : 30 Marks
- Project Phase - I Report (By Evaluation Committee) : 20 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and Project supervisor).

vi) EVALUATION BY GUIDE

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory, it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide.

Project evaluation by the guide: 30 marks

This mark shall be awarded to the students in his/her group by considering the following aspects.

i) Topic selection: 2 marks
Innovativeness, social relevance etc.

ii) Problem definition: 2 marks
Identification of the social, environmental and ethical issues of the project problem.

iii) Purpose and need of the project: 3 marks
Detailed and extensive explanation of the purpose and need of the project.

iv) Project Objectives: 2 marks
All objectives of the proposed work are well defined, Steps to be followed to solve the defined problem are clearly specified.

v) Project Scheduling and Distribution of work among team members: 3 marks
Detailed and extensive scheduling with timelines provided for each phase of project. Work breakdown structure well defined.

vi) Literature Survey: 4 marks
Outstanding investigation in all aspects.

vii) Student's diary/Daily log: 7 marks

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches and drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide.

viii) Individual Contribution: 7 marks

The contribution of each student at various stages.

EVALUATION RUBRICS PROJECT PHASE I: INTERIM EVALUATION						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE 1 INTERIM EVALUATION (20 MARKS)						
1-a	Topic identification, selection, formulation of objectives and/or literature survey (Group assessment) [CO1]	10	• The team has failed to come with a relevant topic. • The review of literature provides very little of the background information on the relevant topic. • No critical analysis or identification of gaps is carried out. • Most of the statements are quoted directly and the team tried to gather information as such without verifying the authenticity. • No literature review was properly conducted and no objectives formed so far.	• The team has identified a topic. • The review of literature provides some of the background information and needs to be revised. • Critical analysis of the literature is missing and suggestions were given to improve the relevance and to identify the gaps. • Relevant references were missing and there is no clear evidence to explain the topic identified. • Identified some objectives but not strong enough to explain it.	• The selection of topic is relevant after brainstorming and good evidences are documented. • The review of literature is appropriate and most background information is provided. • The relevant references were clearly reviewed but there is scope of improvement • Objectives identified with good clarity but some objectives need to be improved.	• The topic selected is highly relevant to real world problem and is potentially innovative. • The team shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. • Literature review was also conducted well. • Identified gaps, problems and made inferences from literature review • The team has come up with clear objectives which are viable.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Socio-environmental relevance/ Innovation/ Creativity (Group assessment) [CO2]	5	• The objective of the project has neither social nor environmental relevance. • The project does not involve elements of creativity and innovation.	• The objective of the project has least social or environmental relevance. • No major contributions in innovative aspects.	• The objective of the project is socially or environmentally relevant. • The project involves some elements of creativity and innovation.	• The objective of the project has great social/environmental relevance. • The objective is highly innovative and involves creativity.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

1-c	Project Planning, Scheduling and Resources/ Tasks Identification and allocation. (Group assessment) [CO2]	5	• No evidence of planning or scheduling of the project. • The students did not have any idea on what materials / resources to be used in the project. • The students do not have any awareness on the budget required.	• Some evidence of a primary plan. • Some ideas on the materials /resources required. • The students have some idea on the finances required and they have not formalized a budget plan. • Some indication on task allocation among the team members.	• Good evidence of planning done. Materials were listed and thought out, but needs improvement. • Schedules prepared were not a detailed one. • Better task allocation among group members.	• Excellent evidence of innovative project planning. • Charts were used to depict detailed project scheduling. • Modern tools were used to track the project. • All materials / resources were identified and listed. • Detailed budgeting is done and each member knows well about their individual tasks.
			(0 -1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Total – 20 marks						

EVALUATION RUBRICS PROJECT PHASE I: FINAL EVALUATION						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE I FINAL EVALUATION (30 MARKS)						
1-d	Formulation of Design / Methodology and Progress (Group assessment) [CO2]	5	• Team members have no idea about the design and the methodology adopted. • Team has no progress after the evaluation. • Extensive support required from the project supervisor to achieve a satisfactory execution of various stages of the project.	• The students have some knowledge on the design procedure to be adopted, and the methodologies. • Not made much progress in the design. • Needs assistance at various stages of the project.	• The team is comfortable with design methods adopted and have made some progress. • The methodologies were known to them to a larger extend. • Adherence to action plan and effective organization of activities. • Needs some assistance from faculty to arrive at feasible solutions to problems.	• The team is having a well-defined design methodology and Excellent knowledge in design procedure. • Good adherence to action plan and organization of activities effectively within the time frame. • Development and implementation of feasible solutions within the time period.
			(0 -1 Marks)	(2-3 Marks)	(4 Marks)	(5 Marks)

1-e	Individual and Teamwork Leadership (Individual assessment) [CO4]	10	• No active involvement in the project. • Quality of the work is uncertain. • The student does not show any interest in the project activities.	• The student shows some interest and participates in some of the activities. • Not a good team player. • Often listens to, shares with and sometimes supports the efforts of others.	• Provide productive suggestions for the betterment of the project. • Usually listens to and tries to keep people working well together as a team • The student shows good interest in project, and takes up tasks and attempts to complete them.	• Successful completion of the assigned part of the project maintaining time frame and shows quality in the work. • Shows excellent responsibility and leadership qualities. Making discussions with peers and supports each other. • Active involvement and provide productive suggestions in interactions with the supervisor.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-f	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility Study (Individual & group assessment). [CO3]	10	• The team has not done any preliminary work with respect to the project area. • Lacks of proper knowledge in the topic. • They need to improve a lot. • Less ability for self-learning.	• The team has started doing some preliminary work with respect to the project. • Finds difficult to answer complex questions related to the project work. • Limited knowledge about the modern tool used in the project.	• The team has done good amount of preliminary investigation • They can improve further. • Can handle complex questions with relative ease. • Adequate knowledge of the modern tool used in the project.	• Student is thoroughly familiar with the topic and can respond confidently and spontaneously to complex questions. • Adequate knowledge of the modern tool used in the project. • The team has completed the required preliminary work and Excellent progress in the project.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-g	Documentation and presentation/ Communication. (Individual & group assessment). [CO3]	5	• Presentation lacks clarity. • Student lack familiarity with the topic. • The individual student contributes only occasionally in the discussions. • The team did not document the work at all. • No weekly discussion with the faculty supervisor and poor maintenance of log book. • The presentation was light in content and dull in appearance.	• Slight difficulty in communicating the contents in English • Interaction with the guide is minimal. • Overall quality needs to be improved • Individual performance desires to be enhanced. • Performance is satisfactory.	• Presentation is clearly structured and appropriate to the audience. • Maintains a log book and most of the project details were documented but needs improvement. • The individual presentation and performance are very good.	• Presentation is well structured and follows the conventions in the field. • Maintains a log book and most of the project details were documented well. • Good eye contact, no direct reading from paper. • Contents properly communicated in good English. • The presentation is done professionally and with great clarity • The performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Total – 30 marks						

	EVALUATION RUBRICS_PROJECT PHASE I: REPORT EVALUATION					
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**VERY GOOD**	**Outstanding**
	PHASE I FINAL EVALUATION (20 MARKS)					
1-h	Report [CO3]	20	• The prepared report is shallow and not as per standard format. • Lack of effort in preparation.	• Project report follows the standard format to some extent. • Language needs to be improved. • All references are not cited properly.	• Systematic documentation and is following the standard format. • Organization of the report is good. • Most of references are cited properly.	• The report is very well organized. • All referencescited properly. • Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 -12 Marks)	(14 - 19 Marks)	(20 Marks)

PROGRAMME ELECTIVE III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41Z	FUNDAMENTALS OF ROBOTICS	PEC	2	1	0	3	2022

i) PRE-REQUISITE: EE1U30I Introduction to Control Engineering

ii) 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.

iii) 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.	Understand
CO2	Select the appropriate sensors and actuators for robots.	Apply
CO3	Identify robotic configuration and gripper for a particular application.	Apply
CO4	Solve forward and inverse kinematics of robotic manipulators.	Apply
CO5	Develop trajectories in joint space and Cartesian space.	Apply
CO6	Develop the dynamic model of a given robotic manipulator and its control strategy.	Apply

iv) 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.

v) (a) TEXT BOOKS

1) S K Saha, *Introduction to Robotics*, Mc Graw Hill Education, 2003.
2) Robert. J. Schilling, *Fundamentals of robotics – Analysis and control*, Prentice Hall of India 1996.
3) R K Mittal and I J Nagrath, *Robotics and Control*, Tata McGraw Hill, New Delhi, 2003.

4) John. J. Craig., *Introduction to Robotics* (Mechanics and control), Pearson Education Asia, 2002.
5) Saeed B. Nikku, *Introduction to Robotics*, Pearson Education, 2001.
6) Rachid Manseur, *Robot Modeling and Kinematics*, Lakshmi publications, 2009.

(b) REFERENCES

1) Ashitava Ghosal, *Robotics-Fundamental concepts and analysis*, Oxford University press.
2) S. R. Deb, *Robotics Technology and Flexible Automation*, 2nd Edition.
3) Boltans W., *Mechatronics*, Pearson Education, 2009.

vi) 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.	**10**
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** 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.	**9**

IV	**Robot Coordinate System s-** 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 and Control 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.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Cate-gory	L	T	P	Credit	Year of Introduction
EE1U41Y	ELECTRICAL SYSTEM DESIGN FOR DOMESTIC DWELLINGS	PEC	2	1	0	3	2022

i) PRE-REQUISITE: EE1U30A: Power Systems I

ii) COURSE OVERVIEW: This course provides a comprehensive understanding of electrical system design for residential buildings, covering fundamental concepts, standards, and practical applications. The course emphasizes safe, efficient, and code-compliant electrical installations while integrating modern energy-efficient and smart home technologies.

iii) 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	Design and select lighting systems for indoor applications.	Apply
CO3	Illustrate the operation of various protective devices associated with domestic electrical installations.	Understand
CO4	Design low/medium voltage domestic electrical installations and select suitable protective devices.	Apply
CO5	Design simple PV system for residential building.	Apply
CO6	Demonstrate the various energy saving aspects in domestic installations	Understand

iv) SYLLABUS

General awareness of IS Codes: IS 732 - IS 3043 IS 2026- IS 3646- IS 5216 - Electricity supply code- NEC - The Electricity Act 2003 Classification of voltages-standards and specifications, tolerances for voltage and frequency.

Indoor Lighting design - Illumination calculations, - Light Loss Factor -Lighting schemes - Types of lamps and luminaries – DLOR, ULOR, LOR – Lighting calculations- Average lumen method

Domestic Installation - Types of domestic wiring systems- selection of number of sub circuits. Principle of operation of MCB, RCCB and RCBO. Importance of earthing - Tariff system - aspects.

Design of electrical system for domestic dwellings for single phase supply (LV) and three phase supply (MV) – Calculation of connected load and sub circuits - Selection of DB, Circuit Breakers and wires. Pre-commissioning tests of domestic installations.

Introduction to Solar PV Systems – Components of PV system - Solar panel efficiencies - PV modules - Design of a PV system for domestic application - selection of equipments. Energy Conservation Techniques in domestic installations.

v) (a) TEXT BOOKS

1) J. B. Gupta, *A Course in Electrical Installation Estimating and Costing*, S.K. Kataria & Sons; Reprint 2013 edition, 2013.

2) K. B. Raina, S. K. Bhattacharya, *Electrical Design Estimating Costing*, NEW AGE; Reprint edition, 2010.
3) M. K. Giridharan, *Electrical Systems Design*, I K International Publishers, New Delhi, 2nd edition, 2016.
4) Theodore R Bosela, *Electrical Systems Design*, Prentice Hall; 1st edition, 2002.

(b) REFERENCES

1) *National Electric Code*, Bureau of Indian Standards publications, 2011.
2) Relevant Indian Standard – specifications (IS – 732, IS – 746, IS – 3043, IS – 900)
3) S. L. Uppal, *Electrical Wiring Estimating & Costing*, Khanna Publishers, 2008
4) U.A. Bakshi, V.U. Bakshi, *Electrical Technology*, Technical publications, Pune, 1st Edition, 2020.

Data Book (Approved for use in the examination):

1) M K Giridharan, *Electrical Systems Design Data Hand book*, I K International Publishers.

vi) 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 - Electricity supply code-2014 (Relevance of each code in electrical installation applications only). The Electricity Act 2003- General introduction- Distribution of Electricity (Part VI)- Central Electricity Authority (Part IX)- Regulatory Commissions (Part IX). National Electric Code (NEC 2011) – Scope. Graphical symbols and signs as per NEC for electrical installations. Classification of voltages-standards and specifications, tolerances for voltage and frequency.	**7**
II	**Indoor Lighting design:** Definitions of luminous flux, Lumen, Luminous intensity/illuminance (Lux), Illumination calculations, Coefficients of Utilization (CoU) - factors affecting CoU - Light Loss Factor (LLF). Lighting schemes - Types of lamps and luminaries – DLOR, ULOR, LOR – Lighting calculations- Average lumen method - Space to mounting height ratio - Design of lighting systems for a medium area seminar hall using LED luminaires.	**9**
III	**Domestic Installation:** General aspects as per NEC and IS 732 related to the design of domestic dwellings. General rules for wiring- Common power ratings of domestic gadgets- Types of domestic wiring systems. Connected load-diversity factor - selection of number of sub circuits. Types of distribution boards to provide over load, short circuit and earth leakage protection. Principle of operation of MCB, RCCB and RCBO. Types of MCBs-selection. Selective coordination Importance of earthing- step potential and touch potential-safety aspects and first aid. **Tariff system**-aspects- simple problems in billing.	**9**

IV	**Design of electrical system for domestic dwellings** for single phase supply (LV) and three phase supply (MV) – Calculation of connected load and sub circuits - Selection of DB, Circuit Breakers and wires- Preparation of schematic diagrams and physical layout drawings. Preparation of schedule of works and bill of quantities (cost estimation excluded). **Pre-commissioning tests of domestic installations:** Insulation resistance measurement, continuity test, polarity test, and earth resistance measurement as applicable to domestic installations.	**10**
V	**Introduction to Solar PV Systems:** off-grid and on-grid systems – Components of PV system - PV modules - types, selection criteria - Design of a PV system for domestic application - selection of equipments. **Energy Conservation Techniques in domestic installations** - Smart home electrical systems (IoT-based automation, wireless control, and sensors) - Home energy management systems (HEMS) and smart metering	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41X	DISTRIBUTED GENERATION AND SMARTGRID	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: To develop a conceptual introduction to various distributed generation systems, micro grids, smart grids and their control

iii) COURSE OUTCOMES

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

CO1	Explain various distributed generation systems.	Understand
CO2	Explain the micro grids and their control schemes.	Understand
CO3	Explain the protection issues and pricing in Smart grids.	Understand
CO4	Explain the demand side management and communication systems in Smart grid.	Understand
CO5	Explain Smart substation and various power quality issues in smart grid.	Understand

iv) SYLLABUS

Introduction to distributed generation and smart grids - Distributed Energy Resources – Micro Grids and their control – Protection issues for Smart grids - Smart meters - Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU) Electricity tariff - Demand response- Demand Side Management. HAN, NAN, SANET, Smart Substations, Power Quality issues with smart grid.

v) (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

(b) REFERENCES

1) Remus Teodorescu, Marco Liserre, Pedro Rodriguez, *Grid Converters for Photovoltaic and Wind Power Systems*, ISBN: 978-0-470-05751-3, Wiley
2) S. Chowdhury, S.P. Chowdhury and P. Crossley, *Microgrids and Active Distribution Networks*, ISBN 978-1-84919-014-5, IET, 2009.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Distributed generation:** Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economic advantages of Microgrid-Challenges and disadvantages of Microgrid development **Smart Grid:** Evolution of Electric Grid - Definitions and Need for Smart Grid, Opportunities, challenges and benefits of Smart Grids	9
II	**Distributed energy resources:** Introduction - Combined heat and power (CHP) systems - Solar photovoltaic (PV) systems – Wind energy conversion systems (WECS) - Small-scale hydroelectric power generation. **Control of Microgrids:** Introduction to Central Controller (CC) and Microsource Controllers (MCs) - Control functions of microsource controllers, Active and reactive power control, Voltage control, Storage requirement for fast load tracking, Load sharing through power-frequency control.	9
III	**Protection issues for Smart grids:** Introduction, Islanding, Different islanding scenarios, Major protection issues of standalone Microgrid - Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols. Introduction to Smart Meters, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU). Electricity tariff – one-part tariff, two tariff and maximum demand tariff - Dynamic pricing: time-of-use (TOU) pricing, critical-peak pricing (CPP) and Real Time Pricing. Automatic Meter Reading (AMR), Smart Sensors, Energy efficient devices-Home & Building Automation.	9
IV	Smart distributed energy resources and their grid integration. Load Curves-Load Shaping Objectives-Methodologies - Peak load shaving Energy Management-Role of technology in demand response- Demand Side Management. Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood-Area Networks (NANs), Sensor and Actuator Networks (SANETs).	9
V	Smart Substations, Substation Automation, IEC 61850 Substation Architecture, Feeder Automation. Power quality: Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker - Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights) Power quality aspects with smart grids.	9
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41W	SPECIAL ELECTRICAL MACHINES	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EE1U20D: DC Machines and Transformers, EE1U30D: Synchronous and Induction Machines, EE1U30I: Introduction to Control Engineering.

ii) COURSE OVERVIEW: The goal of this course is to get an overview of special electric machines for control and industrial applications.

iii) COURSE OUTCOMES

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

CO1	Illustrate the principle of operation of permanent magnet DC motor and Brushless DC motor.	Understand
CO2	Outline the classification of stepper motors and its characteristics.	Understand
CO3	Infer the operation of reluctance motors and the various power converter circuits employed in switched reluctance motors.	Understand
CO4	Explain the principle of various single-phase motors and linear motors along with their pros and cons.	Understand
CO5	Develop the drive circuits for various machine applications by applying fundamental concepts.	Apply

iv) SYLLABUS

Permanent Magnet DC Motors - Brushless DC motor – Construction – Principle of operation.

Stepper motors – Basic principle – Classification – Types of excitations – Characteristics – Applications.

Reluctance motors, Synchronous Reluctance Motor – Principle of operation - Torque equation – Characteristics – Applications; Switched reluctance motors – Principle of operation – Power converter circuits – Applications.

Single Phase Special Electrical Machines: AC Series Motor, Hysteresis Motor, Repulsion Motor, Universal Motor.

Linear Electric Machines- Linear Induction Motor, Linear Synchronous Motor, Linear Reluctance Motor, Linear Levitation Machines.

v) (a) TEXT BOOKS

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

(b) REFERENCES

1) Irving L. Kosow, *Electrical Machinery and Transformers*, Pearson, 2nd Edition 2007.

2) Veinott & Martin, *Fractional & Sub-fractional Horsepower Electric Motors*, McGraw Hill, 4th Edition, 1986.
3) Paul Acamley, *Stepping Motor – A Guide to Theory and Practice*, IEE London, 2002.
4) B. K. Bose, *Modern power electronics and AC drives*, Prentice Hall of India, N J, 2002.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Permanent Magnet DC Motors:** Construction-Principle of operation -Torque equation–Performance characteristics -Applications. **Brushless DC motors:** Classification- Construction-Principle of operation –Electronic commutator-BLDC square wave- BLDC sine wave - Comparison - Applications - Drive circuits.	**9**
II	**Stepper motors:** Basic Principle - Classification – Variable Reluctance - Permanent Magnet - Hybrid type – Comparison - Theory of operation – Types of excitation mode- Static and Dynamic characteristics - Drive circuits – Bipolar and Unipolar-Open loop and Closed loop control of Stepper motors –Applications.	**9**
III	**Synchronous Reluctance Motor (SyRM):** Construction of SyRM, Principle- Phasor Diagram and Torque Equation - Torque-speed characteristics- Control of SyRM - Applications. **Switched Reluctance Motors** – Construction – Principle- Torque equation- Torque-Speed characteristics-Power converter circuits– Rotor position sensors-Control of SRM -Sensorless control of SRM - Applications. MATLAB Simulation.	**10**
IV	**Single-Phase Special Electric Machines:** AC Series Motor, Hysteresis Motor, Repulsion Motor, Universal Motor - Construction - Principle of operation-Torque Equation- Phasor Diagram- Characteristics -Speed control of Universal Motor-Applications.	**8**
V	**Linear Electric Machines:** Linear Induction Motor - Types of forces, Thrust equation, Thrust-speed characteristics, End effect and Transverse edge effect. Linear Synchronous Motor, Linear Reluctance Motor, Linear Levitation Machines – Principle of operation- Applications.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41V	EMERGING TECHNOLOGIES IN SPORTS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course explores the cutting-edge technologies reshaping the sports industry. By the end of the course, students will have a comprehensive understanding of the current technological landscape in sports and how these technologies are driving the future of the industry.

iii) COURSE OUTCOMES

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

CO1	Explain the basic concepts, evolution, and current applications of emerging technologies in the sports industry.	Understand
CO2	Extend the role of data analytics in sports, recognizing how data-driven insights improve performance, safety, and team strategy.	Understand
CO3	Apply the applications of AI and ML in sports, particularly in performance analysis, injury prevention, and decision-making.	Apply
CO4	Summarize how wearable technologies contribute to tracking, improving, and optimizing athletes' physical performance and overall well-being.	Understand
CO5	Outline the impact of VR and AR on sports, with a focus on their use in training, injury rehabilitation, and enhancing the spectator experience.	Understand

iv) SYLLABUS

Introduction to Sports Technology: Overview, Current technological trends, Role of technology in enhancing performance, safety, and fan experience

Data Analytics and Sports Performance: Types of sports data, Tools used for data collection: Sensors, cameras, GPS, etc., Basic data analysis techniques

Artificial Intelligence and Machine Learning in Sports: Basics of Artificial Intelligence (AI) and Machine Learning (ML), AI-driven tools for performance analysis and coaching, Player injury prediction and prevention using machine learning models, Video analysis for game strategy and tactical decisions, Case studies

Wearable Technologies and Biomechanics in Sports: Types of wearable devices: Benefits for monitoring health and performance, Biomechanical analysis through wearables, Integration of wearable technology with sports training and injury prevention

Virtual and Augmented Reality in Sports: Applications of VR/AR in sports. Use of AR for fan experiences.

v) (a) TEXT BOOKS

1) Benjamin C. Alamar, *Sports Analytics: A Guide for Coaches, Managers, and Other Decision Makers,* Ist Edition, published by Columbia Univ Pr, 2013.
2) Jonathan Harris, *Artificial Intelligence in Sports: Revolutionizing Performance and Fan Engagement,* Kindle Edition, 2024.
3) Thomas W. Miller**,** *Sports Analytics and Data Science: Winning the Game with Methods and Models*, 1st Edition, Pearson Education, Inc., 2016.
4) Giuliana Guazzaroni, Anitha S. Pillai, *Virtual & Augmented Reality in Education, Art, and Museums*, IGI Global, 2019.
5) Duarte Araújo, Micael Couceiro, Ludovic Seifert, Hugo Sarmento, Keith Davids, *Artificial Intelligence for Sports Performance Analysis*, 1st Edition, Routledge, 2019.

(b) REFERENCES

1) David E. Sappington, *"The Data Science of Sports: How Data is Changing the World of Athletics",*
2) *Sports Technology and Innovation*, EdX/MIT (Online Course).
3) Sarkar, S., & Joshi, D, *AI-Driven Video Analysis for Tactical Decision Making in Football*, Journal of Sports Analytics, 2020, Vol. 5, Issue 1, pp. 45-60.
4) Wang, J., & Li, M**.** *Applications of Augmented Reality in Stadiums: Enhancing Fan Experience and Engagement*, Journal of Sports Entertainment and Technology, 2021, Vol. 14, Issue 2, pp. 32-44.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Sports Technology:** Overview of sports technology and its evolution, Current technological trends in the sports industry, Role of technology in enhancing performance, safety, and fan experience, Key technological domains in sports: Wearables, AI, Data Analytics, AR/VR, etc., Ethical implications of technology use in sports. Industry Examples: Hawk-Eye Innovations, NBA Smart Arenas.	**9**
II	**Data Analytics and Sports Performance:** Introduction to sports data analytics, types of sports data (player performance, injury tracking, fan engagement, etc.), Tools used for data collection: Sensors, cameras, GPS, etc., Basic data analysis techniques for sports (descriptive and predictive analytics), Real-life examples of sports analytics: Teams using data for decision-making. Industry Examples: Real-time tracking data from RFID chips in players' pads, IBM SlamTracker.	**9**
III	**Artificial Intelligence and Machine Learning in Sports:** Basics of Artificial Intelligence (AI) and Machine Learning (ML), AI-driven tools for performance analysis and coaching, Player injury prediction and prevention using machine learning models, Video analysis for game strategy and tactical decisions, Case studies: AI in professional sports teams and competitions.	**9**

	Industry Examples: Second Spectrum (NBA & Premier League) – AI-based video analysis and tactical insights, Zone7 – Predictive analytics to prevent injuries, used by football and cycling teams.	
IV	**Wearable Technologies and Biomechanics in Sports:** Introduction to wearable technologies in sports (fitness trackers, smartwatches, heart rate monitors)**,** Types of wearable devices: Benefits for monitoring health and performance**,** Biomechanical analysis through wearables**,** Integration of wearable technology with sports training and injury prevention**,** Real-world examples of wearable devices used by athletes and teams. Industry Examples: Whoop Strap, STATSports Apex, Motus Sleeve.	**9**
V	**Virtual and Augmented Reality in Sports:** Introduction to Virtual Reality (VR) and Augmented Reality (AR)**,** Applications of VR/AR in sports training, rehabilitation, and fan engagement**.** Use of AR for fan experiences (stadium experiences, live games, etc.)**,** The future potential of VR/AR in transforming sports entertainment and training. Industry Examples: STRIVR Labs, AR overlays by FOX Sports.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41U	POWER SYSTEM PROTECTION	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U40B: Power System Engineering

ii) 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

iii) 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, and numerical relays 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

iv) 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 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.

v) (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, D. N. Vishwakarma, *Power System Protection and Switchgear*, Tata McGraw Hill, 2nd edition, 1994.
3) J. B. Gupta, *A course in Electrical Power*, Kataria and Sons, 2013 edition.

(b) REFERENCES

1) Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, *Protection and Switchgear*, Oxford Higher Education, 2011 edition.
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, S. R. Bhide, *Fundamentals of Power System Protection*, PHI, 1st Edition, 2009.

vi) 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.	8
II	**Relay Construction and Operating Principles:** Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays. **Overcurrent Protection:** Introduction, Time–current Characteristics, Current Setting, 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, 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. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.	8
IV	**Pilot Relaying Schemes:** Introduction, Wire Pilot Protection, Carrier Current Protection. **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, Protection of Generators. **Transformer and Buszone Protection:** Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection.	10

V	**Circuit Breakers:** Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, 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.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U41D	DATA STRUCTURES	PEC	2	1	0	3	2023

i) PRE-REQUISITE: ES0U10E: Programming in C.

ii) COURSE OVERVIEW:

This course aims to introduce the various data structures, their organization, and operations. It covers abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps, and graphs. It helps the learner to apply appropriate data structures and associated algorithms for solving real world problems efficiently.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamental concepts of data structures, algorithms, and performance analysis, alongside demonstrating the ability to articulate arrays, searching techniques, linked lists, memory management, trees, and graphs.	Understand
CO2	Apply arrays, stacks, queues, and searching algorithms effectively to solve real-world problems, demonstrating proficiency in algorithmic problem-solving.	Apply
CO3	Apply a linked list to represent a data item required to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem.	Apply
CO4	Apply comprehensive understanding and practical skills in trees, binary trees, binary search trees, and graph algorithms	Apply
CO5	Explain the sorting algorithms and different hashing techniques used.	Understand

iv) SYLLABUS

Introduction: Basic Concepts of Data Structures, Algorithms, Performance Analysis, Asymptotic Notation, Complexity Calculation of Simple Algorithms.

Arrays and Searching: Sparse matrix, Stacks and Queues, Linear Search and Binary Search.

Linked List: Operations on Linked List, Types of Linked Lists, Stacks and Queues.

Trees and Graphs: Binary Trees, Binary Search Trees, Graph Representations, Depth First Search and Breadth First Search, Applications of Graphs.

Sorting and Hashing: Selection Sort, Insertion Sort, Quick Sort, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions.

v) (a) TEXT BOOKS

1) Ellis Horowitz, *Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C*, 2nd Edition, Universities Press, 2007.

(b) REFERENCES

1) Samanta D., *Classic Data Structures*, 2nd Edition, Prentice Hall India Learning Private Limited, 2009.
2) Richard F. Gilberg, Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, 2nd Edition, Cengage Learning, 2005.
3) Aho A. V., J. E. Hopcroft and J. D. Ullman, *Data Structures and Algorithms*, Pearson Publication, 1982.
4) Tremblay J. P. and P. G. Sorenson, *Introduction to Data Structures with Applications*, Tata McGraw Hill, 1984.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Basic Concepts of Data Structures, System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms.	**8**
II	Arrays and Searching: Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions, Linear Search and Binary Search.	**9**
III	Linked List: Self-Referential Structures, Dynamic Memory Allocation, Operations on Linked List - Singly Linked List, Doubly Linked List. Stacks and Queues using Linked List, Polynomial representation using Linked List.	**10**
IV	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations, Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs.	**9**
V	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort. Hashing, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

OPEN ELECTIVE II

Course Code	Course Name	Cate-gory	L	T	P	Credit	Year of Introduction
EE0U41Z	ARCHITECTURAL LIGHTING DESIGN AND CONTROL	OEC	2	1	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course explores the principles of architectural lighting design and control, covering fundamental lighting concepts, lamp technologies, and luminaire types. It includes interior, exterior, and specialized lighting designs, emphasizing energy efficiency, daylight integration, and automation using smart control systems. Students will gain insights into modern lighting techniques, sustainable solutions, and real-world applications in buildings, streets, and urban environments.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamental principles of light, illumination, and various lamp technologies used in architectural lighting.	Understand
CO2	Develop the lighting scheme for efficient indoor lighting system	Apply
CO3	Develop the lighting scheme for efficient outdoor lighting system	Apply
CO4	Illustrate smart lighting control systems, including dimmers, sensors, automation techniques, and IoT-based lighting solutions.	Understand
CO5	Explain energy-efficient lighting solutions, daylight harvesting techniques, and sustainable lighting practices for modern architecture.	Understand

iv) SYLLABUS

Fundamentals of Light and Lamps – Basics of light, Luminous flux, Lumen, Luminous intensity, Lamp types – Fluorescent, LED, Sodium vapour, Mercury vapour, Metal halide, Luminaire types – Reflectors, refractors, mounting types, Fixture selection.

Interior Lighting Design – Illumination calculations, Average lumen method, Space-to-mounting height ratio, Lighting design for seminar halls, offices, residences, Staircase, corridor, and entrance lighting, Human-centric lighting.

Outdoor and Specialized Lighting – Road and street lighting, Spacing-to-mounting height ratio, Flood lighting, Façade lighting, Landscape and garden lighting, Sports lighting.

Smart and Automated Lighting Systems – Lighting control methods, Dimmers, Motion and occupancy sensors, Photo sensors, Timers, IoT-based lighting, Smart city lighting automation.

Sustainable and Energy-Efficient Lighting – Daylight factor, Daylight harvesting techniques, Energy-efficient lighting sources, Lighting control systems – Analog, digital, networked, Dimming techniques – DALI, DMX, Green building lighting strategies.

v) (a) TEXT BOOKS

1) Robert Simpson, *Lighting Control: Technology and Applications*, Taylor and Francis, 2003.

2) Craig DiLouie, *Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications*, CRC Press, 2005.
3) M K Giridharan, *Electrical System Design*, I K International Publishing House Pvt. Ltd, 2015.
4) B.R. Gupta, *Power System Analysis and Design*, S. Chand, 2020.
5) M.S. Rea, *The IESNA Lighting Handbook*, Illuminating Engineering Society of North America (IESNA), 10th Edition, 2011.
6) R. G. Hopkinson, *Lighting for Architecture*, Elsevier, 2013.
7) D. DiLaura, K. Houser, R. Mistrick, G. Steffy, *The Lighting Handbook*, 10th Edition, IESNA, 2011.

(b) REFERENCES

1) D.C. Pritchard, *Lighting*, 6th edition, Routledge, 2014
2) Jack L. Lindsey, *Applied Illumination Engineering*, The Fairmont Press Inc.
3) M.A. Cayless, *Lamps and Lighting*, Routledge, 1996.
4) J.B.Murdoch, *Illumination Engineering from Edison's lamp to the laser* Macmillan Publishing company
5) Mohamed Boubekri, *Daylighting, Architecture and Health: Building Design Strategies* Architectural Press, UK.
6) Mark Karlen, James Benya, *Lighting Design Basics*, Wiley, 3rd Edition, 2017.
7) Peter Tregenza, David Loe, *The Design of Lighting*, Routledge, 2013.
8) Gary Gordon, *Interior Lighting for Designers*, Wiley, 5th Edition, 2015.
9) Wayne C. Turner, *Energy Management Handbook*, Fairmont Press, 9th Edition, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Light and Lighting Systems** Basics of light – Luminous flux, Lumen, Luminous intensity, Types of lamps – Fluorescent, LED, High & Low-pressure sodium vapour, Mercury vapour, Metal halide, Comparative analysis of lamp technologies – Energy efficiency, lifespan, color rendering, Types of luminaires – Reflectors, refractors, mounting types, Fixture selection based on applications - Lighting schemes	9
II	**Interior Lighting Design** Maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilization-LLF- factors affecting it - Illumination calculations – Average lumen method, Space to mounting height ratio, Interior lighting design – Seminar halls, offices, residential spaces, Factors affecting visual comfort, glare, and aesthetics, Lighting for staircases, corridors, and entrances, Human-centric lighting – Color temperature and circadian rhythms.	10
III	**Outdoor and Specialized Lighting** Road lighting design – Spacing to mounting height ratio, Requirements of good road lighting, Street lighting arrangements – Pole placements and fixture types, Flood lighting design – Selection of lamps and	9

	projectors, Facade lighting for buildings, Landscape and garden lighting, Sports lighting.	
IV	**Smart and Automated Lighting Systems** Purpose of lighting control – Benefits of automation, Overview of dimmers, motion and occupancy sensors, photo sensors, and timers, Smart lighting for buildings and streets – Introduction to IoT-based lighting, Case studies on modern lighting automation in smart cities and smart homes.	**9**
V	**Sustainable and Energy-Efficient Lighting** Daylight factor – Daylight harvesting techniques, Benefits of daylighting, Overview of lighting control systems – Analog, digital, networked, Basics of dimming techniques – DALI, DMX for architectural lighting, Role of lighting in green buildings, Case studies on energy-efficient lighting in urban environments.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0U41Y	ELECTRIC VEHICLES	OEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The main goal of this course is to expose the students to the fundamental concepts and trends in electric and hybrid vehicles. It gives an insight into the drive system, battery management system and energy sources used in electric vehicles.

iii) COURSE OUTCOMES

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

CO1	Illustrate the basic concepts of electric and hybrid electric vehicles.	Understand
CO2	Compare the various configurations of electric and hybrid electric drive trains.	Understand
CO3	Explain the propulsion unit for electric and hybrid vehicles	Understand
CO4	Summarize various energy storage systems for vehicle applications.	Understand
CO5	Compare various communication protocols and technologies used in vehicle networks.	Understand

iv) SYLLABUS

Conventional Vehicles, Basics of vehicle performance, Basic Architecture of hybrid traction, Electric Drive Drain, Power flow control.
Electric Propulsion unit, Configuration and control of DC motor drives, Induction Motor drives.
Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, fuel cell, flywheel and supercapacitor-based energy storage.
Communication Systems, Energy Management Strategies, EV charging technologies and policies.

v) (a) TEXT BOOKS

1) Iqbal Husain: *Electric and Hybrid vehicles: Design Fundamentals,* CRC press, 3rd Edition 2021.
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.

(c) ONLINE RESOURCES

1) NPTEL courses/Materials (IITG, IITM,IITD) – Electric and Hybrid vehicles
https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)
https://nptel.ac.in/courses/108/106/108106170/ (IIT Madras)
2) FOC Control - video lecture by Texas Instruments
https://training.ti.com/kr/field-oriented-control-permanent-magnet-motors
3) Sensored and sensorless FOC control of PMSM motors – Application notes (TI, MATLAB)
https://www.ti.com/lit/an/sprabz0/sprabz0.pdf?ts=1620018267996&ref_url=https%253A%252F%252Fwww.google.com%252F
https://in.mathworks.com/help/physmod/sps/ref/pmsmfieldorientedcontrol.html
4) Electric Vehicle Conductive AC Charging System
https://dhi.nic.in/writereaddata/UploadFile/REPORT%20OF%20COMMITTEE636469551875975520.pdf
Electric Vehicle Conductive AC Charging System

vi) 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. **Basics of vehicle performance**, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	9
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.	9
III	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles. Configuration and control of separately excited DC motors, Induction Motors (block diagram representation of FOC).	9
IV	**Energy Storage**: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems - Fuel Cell based energy storage systems- Introduction to Supercapacitors and Hydrogen energy storage - Hybridization of different energy storage devices **Types of charging stations** - AC Level 1 & 2, DC - Level 3 Charging –V2G concept.	10

V	**Communications**, supporting subsystems: In vehicle networks- Communication Protocols - CAN, LIN, FLEXRAY (Basics only) **Introduction to energy management strategies**: Classification of different energy management strategies, comparison of different energy management strategies	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0U41X	PROCESS CONTROL AND AUTOMATION	OEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

The course aims to familiarise students with the concepts of process control. It presents basic control system concepts to enable students to model and analyse physical systems in time domain. Students will be introduced to classical controllers and advanced control strategies used in process control. The different components like actuators, control valves, PLCs and industrial robots used for process automation will also be introduced.

ii) COURSE OUTCOMES

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

CO1	Explain the basic concepts of control systems.	Understand
CO2	Apply time domain techniques for response analysis of physical systems.	Apply
CO3	Explain the concepts of system stability, types of classical controllers and advanced control strategies in process control.	Understand
CO4	Explain the architecture of Industrial Automation Systems and its components.	Understand
CO5	Build simple ladder programs for operation of PLC.	Apply
CO6	Explain the use of industrial robots.	Understand

iii) SYLLABUS

Basic concepts of control systems - Process control block diagram – Control system evaluation – Transfer function - Modeling of physical systems – Response analysis of first order and second order systems - Linearisation - Time domain and frequency domain specifications – Transportation lag – Concept of stability – On-off, P, PI and PID Controllers – Ziegler Nichol's tuning method - Advanced control strategies – Process Identification -Automation architecture - Actuators - Control Valves- Discrete state process control - Programmable Logic Controllers - Ladder programming – Industrial robots – Robot subsystems, classification and Applications.

iv) a) TEXTBOOKS

1) Coughanowr, D. R., LeBlanc S., *Process Systems Analysis and Control*, 3rd edition, McGraw-Hill, 2008.
2) C. D. Johnson, *Process control Instrumentation Technology*, Pearson Education, Eighth Edition, 2006, PHI, 8th Edition, 2013.
3) William L. Luyben, *Process Modelling, Simulation and Control for Chemical Engineers*, Mc- Graw Hill, 2nd edition, 1996.

4) Surekha Bhanot, *Process Control - Principles & Applications*, Oxford University Press, 2008.
5) S. K. Saha, *Introduction to Robotics*, McGraw Hill Education Pvt. Ltd., 2nd edition, 2014.
6) Norman S. Nice, *Control Systems Engineering*, 6th edition, 2011.

b) REFERENCES

1) Stephanopoulos G., *Chemical Process Control: An Introduction to Theory and Practice*, Pearson Education (1984), PHI, 2006.
2) B. Wayne Bequette, *Process control: Modeling, Design and simulation*, Prentice Hall of India (P) Ltd., 2003.
3) Huges T, *Programmable Controllers*, ISA press, 4th Edition Illustrated, 2005.
4) Considine D.M., *Process Instruments and Controls Handbook*, Second Edition, McGraw, 1999.
5) G. Liptak, *Handbook of Process Control*, 1996
6) K. Krishnaswamy, *Process Control*, New Age International, 2007.
7) Patranabis D., *Principles of Process Control*, Tata McGraw Hill, New Delhi, 3rd edition, 2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Process Control Systems** Process Control principles – self regulated system, Human aided control, Automatic control, Servomechanisms, Discrete state control systems, Open loop and closed loop systems, Process Control block diagram, Control System evaluation – objective, stability, steady state and transient regulations, Evaluation criteria. Concept of transfer function, Poles and zeros, Type and order, Standard test signals.	9
II	**Linear System Analysis** Time domain specifications – Delay time, Rise time, Peak time, Peak Overshoot, Settling time. Linear open loop systems: Response of first order systems: Step response, impulse response. Physical examples of first order systems: Modelling of liquid level control, mixing process and heating process as first order systems, Concept of linearization of system model. Response of first order systems in series – Non-interacting and interacting systems for liquid level control. Response analysis of second order systems – Undamped, underdamped, critically damped and overdamped systems. Frequency response – Frequency domain specifications – Resonant Peak, Resonant Frequency, Bandwidth, Gain margin and Phase margin. Modelling of transportation lag	9
III	**Closed-Loop Control Systems & PID Controllers** Linear Closed loop systems: Closed loop system - Characteristic equation, Concept of stability, Location of poles and stability, Routh's stability test. Study of ON-OFF control, P, PI and PID controllers, Ziegler Nichol's method for PID tuning.	9

	Advanced Control strategies: Cascade control, Feedforward control, Ratio Control, Smith Predictor control, Selective control, Model Reference Adaptive Control.	
IV	**Industrial Automation & Actuators** Process Identification and automation: Direct methods – Time domain eyeball fitting of Step test data, Direct sine wave testing. Architecture of Industrial Automation Systems: Final control operation – Actuators and Control elements. Actuators – Construction, Principle, Advantages and disadvantages of Hydraulic, Pneumatic and Electrical actuators. Control elements – Control Valves construction and principle, Types –quick opening, linear, equal percentage, Classification	**9**
V	**Discrete State Control & Robotics** Programmable Logic Controllers – architecture and operation, Comparison of PLC & PC, Relays and Ladder Logic, Ladder Programming – Basic symbols used, Realization of AND, OR logic, Concept of latching. Introduction to Timer/Counters- Simple ladder programs Industrial Robots: Robot Subsystems – Motion, Recognition and Control subsystems, Classification of Robots – Based on work envelope, actuation and motion control methods, Industrial Applications – Material handling, welding, spray painting, machining, assembling.	**9**
	Total hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

ix) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0U41W	SUSTAINABLE ENERGY MANAGEMENT	OEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

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

iii) 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 management strategies in industries and commercial establishments.	Apply
CO4	Explain Demand Side Management techniques.	Understand
CO5	Make use of various methods for economic energy analysis.	Apply

iv) SYLLABUS

Energy Management - General Principles and Planning. Energy management opportunities in Lighting, Transformers and Motors.
Energy management in industries and commercial establishments-Energy conservation in boiler and steam. Heat recovery systems - cogeneration.
Demand Side Management - techniques of DSM. Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.
Energy Economics - Economic analysis - methods. Computer aided Energy Management Systems.

v) (a) TEXT BOOKS

1) Craig B. Smith, Kelly E Parmenter, *Energy management principles: Applications, Benefits, Savings*, 2nd edition, Pergamon Press, 2001.
2) Charles M. Gottschalk, *Industrial Energy Conservation*, John Wiley & Sons, 1996.
3) D. Yogi Goswami, Frank Kreith, *Energy Management and Conservation Handbook*,2nd edition, CRC Press, 2007.
4) G.G. Rajan, *Optimizing energy efficiencies in Industry*, Illustrated edition, Tata McGraw Hill, Pub. Co., 2001.

(b) REFERENCES

1) IEEE recommended practice for energy management in industrial and facilities.

2) IEEE std 739 - 1995 (Bronze book).
3) M. Jayaraju and Premlet, *Introduction to Energy Conservation and Management*, 3rd edition, Phasor Books, 2008.
4) Paul O'Callaghan, *Energy management*, 1st edition, McGraw Hill Book Co., 1993.
5) Wayne C. Turner, *Energy management Hand Book* - - The Fairmount Press, Inc., 1997.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Energy Management**: General principles of Energy management and Energy management planning. Peak demand control-methodologies. **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. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study.	11
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.	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.	7
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

MINORS/HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0M49A/ EE0M49B	MINI PROJECT	VAC	0	1	6	4	2022

i) PREAMBLE:

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The objective of Project Work is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on 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. Each project assignment should typically include the following:

- Survey and study of relevant published literature on the assigned topic.
- Preparation of an action plan for conducting the investigation, including team roles and responsibilities.
- Development of a preliminary approach to the problem related to the assigned topic
- Documentation of block-level design.
- Conducting preliminary analysis, modeling, simulation, experimentation, design, or feasibility study.
- Preparation of a written report on the study conducted, for presentation to the department.

ii) COURSE OUTCOMES

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

CO1	Identify engineering problems and formulate appropriate solutions.	Apply
CO2	Plan project activities and coordinate effectively within a team to meet deadlines.	Apply
CO3	Evaluate proposed solutions through theoretical analysis and experimental validation.	Evaluate
CO4	Develop technical reports and demonstrate effective communication skills.	Create
CO5	Present technical content clearly and justify ideas with logical reasoning.	Evaluate

iii) COURSE PLAN

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with Faculty-in-charge of mini project /Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the 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. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

iv) CONTINUOUS ASSESSMENT EVALUATION PATTERN

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, 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. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

v) CONTINUOUS INTERNAL EVALUATION (CIE) PATTERN

Attendance	:	10 marks
Marks awarded by Guide	:	15 marks
Project Report	:	10 marks
Evaluation by the Committee	:	40 marks
Total	:	**75 marks**

vi) END SEMESTER EXAMINATION (ESE) PATTERN

Level of completion	:	10 marks
Demonstration of functionality	:	25 marks
Project Report	:	10 marks
Viva-voce	:	20 marks
Presentation	:	10 marks
Total	:	**75 marks**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE
150	75	75

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1H40A	OPERATION AND CONTROL OF GENERATORS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: EE1U20D: DC Machines and Transformers, EE1U30D: Synchronous and Induction Machines. EE1U40D: Power Systems II

ii) COURSE OVERVIEW: The goal of this course is to expose the students to impart knowledge about the broad classification of various electric generator topologies and types of excitation systems. It also intends to deliver the operation and control strategies of induction generators, synchronous generators and Permanent Magnet Synchronous generators.

iii) COURSE OUTCOMES

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

CO1	Compare different excitation systems and explain the various methods used for controlling active and reactive power.	Understand
CO2	Identify the various control schemes for active and reactive power compensation of synchronous generators.	Apply
CO3	Develop a synchronous machine model that incorporates the effect of saliency.	Apply
CO4	Illustrate the construction and principle of operation of Wound Rotor Induction generator and Self-excited Induction generator.	Understand
CO5	Develop the model of Permanent Magnet Synchronous Generators.	Apply

iv) SYLLABUS

Electric generators - types, applications, review.
Excitation systems - block diagram, components, classification, compensation of excitation systems, IEEE type.
Control of active and reactive power - active power and frequency control, automatic generation control, reactive power and voltage control.
Synchronous machine dynamics - stability, swing equation.
Induction generators - operation at power grid, Self-excited induction generators.
Permanent magnet synchronous generators - field distribution, emf and torque, autonomous PMSG.

v) (a) TEXT BOOKS

1) Kimbark E. W., *Power System Stability*, Vol. III, Wiley Publications, 2017.
2) Allen J. Wood., Bruce F. Wollenberg, Gerald B. Sheble, *Power Generation, Operation and Control*, Wiley Publications, New York ,3rd Edition 2013.
3) Kundur P., *Power system stability and control*, McGraw-Hill, 1994.
4) Stevenson W. D., *Elements of Power system analysis*, 1995.
5) Concordia C., *Synchronous Machines*, Wiley Publications, 1958.

(b) REFERENCES

1) Hadi Saddat, *Power System Analysis*, McGraw-Hill, 2002.
2) Fitzgerald A. E., Charles Kingsley Jr., Stephen D. Umans, *Electric Machinery*, McGraw-Hill Higher Education, 6th Edition, 2003.
3) Bhag Singh Guru, Huseyin R. Hiziroglu, *Electric Machinery and Transformers*, Oxford University Press Inc, 3rd Edition, 2000.
4) Bhimbra P. S., *Generalized theory of electrical machines*, Khanna Publishers, 7th Revised Edition 2002.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Electric Generators**- Types of electric generators, generator applications. **Excitation Systems**- Classification-DC, AC and static systems, voltage regulator, power system stabilizer. Compensation of excitation systems- IEEE type excitation systems, instability problem of exciter, solution to the instability of exciter, need for power system stabilizer. Co-ordinated AVR, PSS and speed governor control, FACTS aided control of synchronous generators.	**12**
II	**Control of Active power and Reactive power**: Active power and frequency control-fundamentals of speed governing, control of generating unit power output. Fundamentals of automatic generation control. Reactive power and voltage control-production and absorption of reactive power, methods of voltage control, shunt reactors, shunt capacitors, series capacitors, synchronous condensers, static VAR systems.	**12**
III	**Synchronous Machine Dynamics:** Dynamics of synchronous generators in transient situations, factors affecting transient stability, swing equation, models for stability studies, Synchronous machine model including saliency, steady-state stability-small disturbances, transient stability-equal area criterion-application to sudden increase in power output.	**12**
IV	**Wound rotor Induction Generators**- Construction, steady state equations, equivalent circuit, phasor diagrams, operation at the power grid- stator power versus power angle, rotor power versus power angle and operation at zero slip. **Self-excited Induction Generators**: Cage rotor Induction machine-principle, self-excitation, steady state performance of Three-phase Self-excited Induction generators.	**13**
V	**Permanent Magnet Synchronous Generator Systems:** Configuration and characteristics- air-gap field distribution, emf and torque, stator core loss modelling, circuit model, autonomous PMSGs with controlled constant speed and AC load.	**11**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1H40B	DYNAMICS OF POWER CONVERTERS	VAC	3	1	0	4	2022

i) PRE-REQUISITE: EE1U30G: Power Electronics

ii) COURSE OVERVIEW: The goal of the course is to analyse the steady state equivalent modelling and AC circuit modelling of power electronic converters. It also includes the canonical modelling of converters. The course also imparts knowledge about the transfer function of the converter and controller design.

iii) COURSE OUTCOMES

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

CO1	Model the DC-DC converters under steady state condition.	Apply
CO2	Develop dynamic model of switch mode power converters using state space averaging and circuit averaging techniques.	Apply
CO3	Develop the transfer function of DC-DC converters.	Apply
CO4	Illustrate the closed loop control of DC-DC converters.	Understand
CO5	Explain the discontinuous conduction mode of dc-dc converters	Understand

iv) SYLLABUS

Steady State Converter Analysis - Small-Ripple Approximation, Analysis of buck & boost converter in continuous & discontinuous conduction mode

Steady-State Equivalent Circuit modelling DC Transformer Model, Inductor voltage & capacitor voltage, inclusion of Semiconductor Conduction Losses in converters

AC Equivalent Circuit Modelling Small signal AC modelling of Buck Boost converter, Perturbation and Linearization, Construction of the Small-Signal Equivalent Circuit Model, Equivalent circuit model of a non-ideal flyback converter

State Space Averaging. State space averaging of non-ideal buck boost converter, Canonical Circuit Model of DC DC converters, modelling of pulse width modulator

Converter Transfer Functions. Frequency response analysis, Transfer Functions of the Buck-Boost Converter, graphical construction of converter transfer functions, Controller Design.

v) (a) TEXT BOOKS

1) Robert W Erickson, Dragan Maksimovic, *Fundamentals of Power Electronics*, Springer, 3rd edition, 2001.
2) Taylor Morey, Abraham Pressman, Keith Billings, *Switching Power Supply Design*, McGraw Hill,3rd Edition, 2009.
3) Rashid M.H., *Power Electronics Circuits, Devices and Applications*, 3rd edition, Prentice Hall India, New Delhi, 2014.

(b) REFERENCES

1) Ned Mohan, Undeland, Robbins, *Power Electronics: Converters, Applications and Design*, 3rd ed., John Wiley, 2018.
2) Umanand L, Bhatt, *Design of Magnetic Components for Switched Mode Power Converters,* S R New Age International, New Delhi, 2001.
3) John G. Kassakian, George C. Verghese, *Principles of Power Electronics*, Addison-Wesley Publications, 1991.
4) Muhammad H. Rashid, *Power Electronics, Devices, Circuits and Applications*, Pearson, 3rd edition, 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Fundamentals of Steady state converter modelling and analysis applied to basic DC-DC converters: Buck, boost and buck-boost converter - Principle of volt-sec balance, amp-sec balance, and small-ripple approximation - Steady-state (dc) equivalent circuits, losses and efficiency. Inclusion of semiconductor conduction losses in converter model.	**12**
II	Small-signal AC modelling - Averaging of inductor/capacitor waveforms - perturbation and linearisation. State-Space Averaging-Circuit Averaging and averaged switch modelling- Canonical Circuit Model - Manipulation of dc-dc converters' circuit model into Canonical Form-Modelling the pulse width modulator. (Treatment may be limited to ideal converters. Questions in the end semester examination may be limited to buck and boost converter).	**12**
III	Converter Transfer Functions - Review of frequency response analysis techniques - Bode plots - Converter transfer functions - graphical construction. Converter transfer functions of ideal buck, boost and buck-boost converters - Measurement of ac transfer functions and impedances.	**12**
IV	Controller Design: Effect of negative feedback on the network transfer functions - loop transfer function-Controller design specifications- PD, PI and PID compensators - applications to the basic dc-dc topologies - Practical methods to measure loop gains: Voltage and current injection.	**12**
V	Converters in Discontinuous Conduction Mode: AC and DC equivalent circuit modelling of the discontinuous conduction mode-Generalised Switch Averaging-small-signal ac modelling of the DCM switch network. Transfer functions of ideal buck and boost converters in DCM.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1H40C	CONTROL AND DYNAMICS OF MICROGRIDS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The main goal of this course is to expose the students to the concept of microgrids, power electronic converter circuits, control and protection schemes of microgrids. It also intends to develop a conceptual introduction to the various power quality issues and mitigation techniques in microgrids.

iii) COURSE OUTCOMES

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

CO1	Explain microgrid architecture, types, advantages, disadvantages and dynamic interactions of microgrid with the main grid.	Understand
CO2	Classify the various types of Power Electronic Converters in AC and DC microgrids.	Understand
CO3	Illustrate the various control and protection schemes of microgrids.	Understand
CO4	Summarise the various Power Quality Issues and Mitigation Techniques in microgrids.	Understand

iv) SYLLABUS

Overview of Microgrids, Types, Technical and economical advantages of Microgrid, Challenges and disadvantages of Microgrid development, Dynamic interactions of Microgrid with main grid.

Power Electronic Converters in DC Microgrid, Power Electronic Topologies, Power Electronic Converters in AC Microgrid, Classification of Power Converters for RES, Topologies of the Power Inverters.

Microgrid Control Systems, Various Droop Control Strategies in Microgrids, Fuzzy PID Control of Microgrids, Adaptive and Online Control of Microgrids Using Multi-agent Reinforcement Learning.

Microgrid Protection - AC Microgrid Protection Schemes, Protective Systems in DC Microgrids, Challenges in DC Microgrid Protection, Fault Detection Methods in DC Microgrid.

Power quality issues and mitigation techniques in microgrid, Harmonics and its impact in microgrid.

v) (a) TEXT BOOKS

1) Ali Keyhani, *Design of Smart Power Grid Renewable Energy*, John Wiley & Sons, 2011.
2) James Momoh, *SMART GRID Fundamentals of Design and Analysis*, John Wiley & Sons, 2012.
3) Naser Mahdavi Tabatabaei, Ersan Kabalci, Nicu Bizon, *Microgrids Architectures, Control and Protection Methods*, Power Systems, Springer, 2019.

4) Papia Ray, Monalisa Biswal, *Microgrid: Operation, Control, Monitoring and Protection*, Lecture Notes in Electrical Engineering, Springer, 2020.
5) S. Chowdhury, S. P. Chowdhury and P. Crossley, *Microgrids and Active Distribution Networks*, IET, 2009.

(b) REFERENCES

1) R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, *Electrical Power System Quality*, McGraw-Hill, 2nd edition, 2005.
2) Remus Teodorescu, Marco Liserre, Pedro Rodriguez, *Grid Converters for Photovoltaic and Wind Power Systems*, ISBN: 978-0-470-05751-3, Wiley, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Microgrids-**Distributed Generation and Active Distribution Network, Distributed Energy Resources in Microgrid, The Microgrid Architecture, Types, Technical and Economical advantages of Microgrid, Challenges and disadvantages of Microgrid development, Dynamic interactions of Microgrid with main grid.	**8**
II	**Power Electronic Converters in DC Microgrid**- DC Microgrid System, Power Electronic Topologies-AC/DC Converters (Rectifiers), DC/DC Converters, DC/AC Inverters. **Power Electronic Converters in AC Microgrid-**Classification of Power Converters for RES, Topologies of the Power Inverters (DC-AC Power Conversion)	**12**
III	**Microgrid Control Systems-**Control of Power Electronic Converters in AC Microgrid, DC Microgrid Control, Hierarchical Control in Microgrid, Distributed Control of Microgrids, Intelligent and Adaptive Control, Load Shedding, Emergency and Local Control, Various Droop Control Strategies in Microgrids, Fuzzy PID Control of Microgrids, Adaptive and Online Control of Microgrids Using Multi-agent Reinforcement Learning.	**14**
IV	**Microgrid Protection-**AC Microgrid Protection Schemes-Overcurrent Protection, Protection of Radial Distribution Lines Using Fuses, Protection of Radial Feeders Using Over-Current Relays, Protection of Distribution Lines Having Bi-Directional Power Flow, Adaptive Protection of Active Distribution Networks, Integrated Bus-Bar and Line Protection of Microgrids, Islanding Protection of Microgrid, Multi-source Islanding Detection and Managing Inter-connected Microgrid, Under/Over Voltage Protection, Under/Over Frequency Protection.	**14**
V	**Protective Systems in DC Microgrids-**Challenges in DC Microgrid Protection, Fault Detection Methods in DC Microgrid, Protection Schemes in LVDC Microgrids, Protection Schemes in MVDC and HVDC Microgrids. **Power Quality Issues and Mitigation Techniques in Microgrid-**Harmonics and Its Impact in Microgrid, Mitigation of Current Related Issues.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

SEMESTER VIII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U40A	INDUSTRIAL ECONOMICS AND FOREIGN TRADE	HSC	3	0	0	3	2022

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

The course enables students to make better economic decisions in wage employment and entrepreneurship using economic alternatives and investment alternatives.

iii) COURSE OUTCOMES

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

CO1	Explain the problem of scarcity of resources, consumer behaviour and the equilibrium condition of demand and supply.	Understand
CO2	Demonstrate the production function and equilibrium condition of a producer	Understand
CO3	Survey the impact of market competition in the functional requirement of a firm and pricing of goods and services.	Analyze
CO4	Infer the overall performance of the economy, the regulation of economic fluctuations and its impact on various sections in the society.	Analyze
CO5	Compare the profitability of projects and economic performance of business with the help of capital budgeting methods.	Evaluate
CO6	Determine the current impact of global economic policies on the business opportunities of a firm	Analyze

iv) SYLLABUS

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency.

Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation- causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares - Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio.

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

v) REFERENCE

1) Gregory N Mankiw, *Principles of Micro Economics*, Cengage Publications, 2015.
2) Gregory N Mankiw, *Principles of Macro Economics*, Cengage Publications, 2012.
3) Dwivedi D.N., *Macro Economics*, Tata McGraw Hill, New Delhi, 2018.
4) Mithani D M, *Managerial Economics*, Himalaya Publishing House, Mumbai, 2017.
5) Tulsian, *Financial Management* S Chand & Company 2017.
6) Francis Cherunilam, *International Economics*, McGraw Hill, New Delhi, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	**8**
II	Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.	**8**
III	Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency	**9**
IV	Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation-causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares -Money market and	**11**

	Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio.	
V	Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U40E	COMPREHENSIVE COURSE VIVA	PCC	1	0	0	1	2022

v) COURSE OVERVIEW:

The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

vi) GUIDELINES

1) The course should be mapped with a faculty and practice sessions for solving questions based on the core courses in the curriculum shall be arranged.
2) The Comprehensive Viva Voce will be conducted along with the Final Project Phase II evaluation and assessed by the same three-member committee, comprising the Project Coordinator, an expert from the industry or a research institute, and a senior faculty member from a sister department.
3) The pass minimum for this course is 25.
4) The mark will be treated as internal and should be uploaded along with internal marks of other courses.

vii) MARK DISTRIBUTION

Total marks : 50 (only CIE)
Minimum marks required to pass: 25

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U49C	PROJECT PHASE II	PWS	0	0	12	4	2022

i) PRE-REQUISITE: EE1U49B: Project Phase-I.

ii) COURSE OVERVIEW: The goal of this course is to enable students to apply engineering knowledge in practical problem solving. It equips them to foster innovation in design of products, processes or systems. Also creates an urge to develop creative thinking in finding viable solutions to engineering problems. It also aims to provide a good training for the student(s) in R&D work and technical leadership.

iii) COURSE OUTCOMES

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

CO1	Extend knowledge in solving the real-life engineering problems	Understand
CO2	Plan the project effectively (Analysis / modelling / simulation / design / problem solving / experiment).	Apply
CO3	Validate the prototype / process. (Demonstration and testing)	Analyse
CO4	Comprehend and write effective reports, make effective presentations.	Apply
CO5	Develop professional ethics and communicate effectively.	Apply

iv) GUIDELINES

1. Detailed Analysis /Modelling /Simulation /Problem Solving / for implementation as needed.
2. Final development of product/process, testing, results, inferences, conclusions and future directions.
3. Preparing a paper for Conference presentation/Publication in Journals, based on the quality/quantity of work as adjudged by the evaluation committee.
4. Preparing a report in the standard format for being evaluated by the dept. evaluation committee.
5. Preparing presentations for assessments at various stages.

v) ASSESSMENT PATTERN

Minimum required to pass: 75 marks

Project progress evaluation by Project Supervisor	:	30
Two interim evaluations by the Evaluation Committee (25 marks for each evaluation)	:	50
Quality of the report evaluated by the Evaluation committee	:	30
Final evaluation by a three-member committee	:	40
Total marks	**:**	**150**

The interim evaluation committee comprises HoD or a senior faculty member, Project coordinator and Project supervisor.

The final evaluation committee comprises Project coordinator, Expert from Industry/research Institute and a Senior faculty from a sister department. The same committee will conduct comprehensive course viva for 50 marks.

vi) EVALUATION BY GUIDE

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory, it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide.

Project evaluation by the guide: 30 marks

This mark shall be awarded to the students in his/her group by considering the following aspects.

ix) **Project Scheduling and Distribution of work among team members: 5 marks**
Detailed and extensive scheduling with timelines provided for each phase of project. Work breakdown structure well defined.

x) **Literature Survey: 4 marks**
Outstanding investigation in all aspects

xi) **Student's diary/Daily log: 7 marks**
The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches and drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide.

xii) **Individual Contribution: 9 marks**
The contribution of each student at various stages.

xiii) **Completion of the project: 5 marks**

The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met.

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE-II INTERIM EVALUATION - 1 (25 MARKS)						
2-a	Novelty of idea, and Implementation scope [CO1] [Group Evaluation]	**5**	• The project does not involve elements of creativity and innovation and it's a non-implementable idea. • The work presented so far is not at all the original contribution by the team.	• No major contributions in innovative aspects. Some of the aspects of the proposed idea can be implemented. • There is still lack of originality in the work done so far by the team. • No improvements.	• The project involves some elements of creativity and innovation. It's an implementable project idea. • There is some evidence for the originality of the work done by the team. • The team is doing some independent learning.	• The objective is highly innovative and involves creativity. • Original work done by the team is not yet stated anywhere else and could be a patentable / publishable work.
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO2] [Group Evaluation]	**5**	• No task distribution among team members and do not have any awareness on what to do. • The students did not have any idea on what materials / resources to be used in the project.	• Some indication on task allocation among the team members but not effectively distributed, • Some team members do not have any idea of the responsibilities assigned. • Some identified tasks were not followed independently well.	• Good evidence of planning done. Materials were listed and thought out, but needs improvement. • Better task allocation among group members but some group members heavily loaded. • Mostly the duty is being tracked by the individual members.	• Excellent means of task identification and each member knows well about their individual tasks. • All members are assigned tasks in an equal manner. • The individual members are ensuing the tasks in an outstanding manner.
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-c	Adherence to project schedule. [CO3] [Group Evaluation]	**5**	• No weekly discussion with the faculty supervisor. • No indication of sustained planning or scheduling of the project. • They do not have any idea on the budget required even after the phase I. • Project log book not maintained.	• Maintains a log book and some of the project details were documented. Regular updating is not satisfactory. • There is some improvement in the primary plan prepared during phase I. • The students have not formalized a budget plan. • Schedules were not prepared.	• Maintains a log book and most of the project details were documented but needs improvement. • Good sign of planning done and being trailed up to a good extent after phase I. • Detailed Schedules were not prepared and needs improvement.	• Good adherence to action plan and organization of activities effectively within the time frame. • Excellent indication of widespread project planning and follow-up since phase I. • Tasks are restructured and incorporated in the schedule. • Weekly discussion with the faculty supervisor and proper maintenance of log book.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-d	Interim Results. [CO2] [Group assessment]	**5**	• No interim results to show.	• The team showed some interim results, but they are not complete needs improvements.	• The interim results showed were good and mostly reliable with respect to the current stage but still needs upgrading.	• There were substantial interim results which evidently shows the progress of work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [CO4, CO5] [Individual assessment]	**5**	• The presentation was light in content and dull in appearance. • Very poor presentation. • No interim results.	• Presentation is average. • The student has only a weak idea about the task.	• Good overall presentation. • Presentation is clearly structured and quality is good. • Student has good idea about the team's project.	• Excellent presentation. • The presentation is done professionally and with great clarity. • Student has excellent knowledge of the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Total – 25 marks						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation 2						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE-II INTERIM EVALUATION - 2 (25 MARKS)						
2-f	Application of engineering knowledge [CO2] [Individual Assessment]	**10**	• Have very little idea as how to choose and use modern engineering tools. • The student does not know how to apply engineering knowledge on the design and the methodology adopted. • Application of engineering knowledge in the project is poor.	• Difficulty to identify the skills and modern engineering tools that could be used in achieving the objectives. • The student able to apply some basic knowledge and not able to show the design procedure and the methodologies adopted.	• Able to correctly identify the skills and modern engineering tools applicable to the project work. • The student is able to show application of engineering knowledge in the design and methodologies to a good extent possible.	• Proper selection and effective use of possible techniques, skills and modern engineering tools applicable to the project work. • Excellent knowledge in design procedure. • The student is able to apply engineering knowledge to the problem and develop solutions.
			(0 3 Marks)	(4 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	• No active involvement in the project. • The student does not show any interest. • No Individual participation in the project work.	• The student shows some extent of individual contribution. • Limited to some of the tasks.	• Provide productive suggestions for the betterment of the project. • The individual contribution is obvious. • The student has good volume of contribution in main activities of the project.	• Active involvement and provide productive suggestions in interactions with the supervisor. • Student acting as the prime technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO3] [Group Assessment]	**5**	• Expected outcomes are not achieved yet. • The team is incapable to originate any inferences on the issues observed. • Any kind of remarks or	• Only a few of the expected outcomes are achieved. • Limited inferences are made on the observed issues. • No additional work suggested.	• Many of the expected outcomes are achieved. • Many observations and inferences are made and attempts are taken to identify the issues.	• Most of the specified outcomes are met. • Extensive studies are done and inferences drawn. Most of the issues are addressed and solutions suggested.

			studies are not made.		• Some suggestions are made for further work.	• Clear and effective suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. [CO4] [Individual assessment]	**5**	• Presentation lacks clarity. • The individual student has no idea on the presentation. • The presentation is of poor quality.	• Overall presentation quality needs to be improved • Individual performance desires to be enhanced. • Performance is satisfactory.	• Presentation is clearly structured and appropriate to the audience. • The individual presentation and performance are very good.	• Presentation is well structured and follows the conventions in the field. • The individual's presentation is done professionally and the performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Total – 25 marks						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE-II FINAL EVALUATION (40 MARKS)						
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	• Have very little idea as how to choose and use modern engineering tools. • The student does not know how to apply engineering knowledge on the design and the methodology adopted. • Application of engineering knowledge in the project is poor.	• Difficulty to identify the skills and modern engineering tools that could be used in achieving the objectives. • The student able to apply some basic knowledge and not able to show the design procedure and the methodologies adopted.	• Able to correctly identify the skills and modern engineering tools applicable to the project work. • The student is able to show application of engineering knowledge in the design and methodologies to a good extent possible.	• Proper selection and effective use of possible techniques, skills and modern engineering tools applicable to the project work. • Excellent knowledge in design procedure. • The student is able to apply engineering knowledge to the problem and develop solutions.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	• The project has neither social nor industrial relevance.	• The project has some relevance with respect to social/ industrial application. • The team has not taken much effort to explore further,	• The project is relevant to the society /industry. • The team is mostly fruitful in interpreting the problem into an engineering requirement.	• The project is exceptionally relevant to society/industry. • The team has made outstanding contribution in resolving the problem.
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO2] [Group Assessment]	5	• The project does not involve elements of creativity and innovation and it's a non-implementable idea. • The work presented so far is not at all the original contribution by the team.	• No major contributions in innovative aspects. Some of the aspects of the proposed idea can be implemented. • There is still lack of originality in the work done so far by the team.	• The project involves some elements of creativity and It's an implementable project. • Some sign for the originality of the work done by the team. • Could be transformed into a product.	• The objective is highly innovative and involves creativity. • Original work done by the team is not yet stated anywhere else and could be a patentable / publishable work.
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-m	Quality of results / conclusions / solutions. [CO3] [Group Assessment]	10	• Expected outcomes are not achieved yet. • The team is incapable to originate any inferences on the issues observed. • Any kind of remarks or studies are not made.	• Only a few of the expected outcomes are achieved. • Limited inferences are made on the observed issues. • No additional work suggested.	• Many of the expected outcomes are achieved. • Many observations and inferences are made and attempts are taken to identify the issues. • Some suggestions are made for further work.	• Most of the specified outcomes are met. • Extensive studies are done and inferences drawn. Most of the issues are addressed and solutions suggested. • Clear and effective suggestions made for further work.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-n	Presentation - Part I Preparation of slides. [CO4] [Group Assessment].	5	• Presentation lacks clarity and not in proper format. • The individual student has no idea on the presentation. • The presentation is of poor quality.	• Overall presentation follows proper style formats to some extent. • Language needs to be improved. • All references are not cited properly. • Presentation slides needs to be more professional.	• Presentation is clearly structured and follows proper style format. • Organization of the slides is good. • Most of references are cited properly. • Some of the results are not clearly shown. There is scope for improvement.	• Presentation is well structured and slides are exceptionally good. • The presentation Neatly organized. • All references cited properly. • Figures, Tables and equations are properly numbered, Results are clearly highlighted and its readable
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO5] [Individual Assessment].	5	• The student is not communicating properly. • Poor response to questions.	• The student is able to explain some of the content. • The student requires a lot of efforts to get to the idea. • There are language issues.	• Good presentation/ communication by the student. • The student is able to explain most of the content very well. • A few areas where the student shows lack of preparation. • Language is better.	• Clear and concise communication showed by the student. • Presentation is outstanding. • Very confident and tackles all the questions without hesitation. • Exceptional qualities of a good communicator.
			(0 - 1 Mark)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Total – 40 marks						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
PHASE-II PROJECT REPORT (30 MARKS)						
2-o	Report [CO4]	30	• The prepared report is shallow and not as per standard format. • Lack of effort in preparation.	• Project report follows the standard format to some extent. • Language needs to be improved. • All references are not cited properly.	• Systematic documentation and is following the standard format. • Organization of the report is good. • Most of references are cited properly.	• The report is very well organized. • All referencescited properly. • Language is excellent and follows standard styles.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Total – 30 marks						

PROGRAMME ELECTIVE IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42Z	COMMUNICATION ENGINEERING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course aims to provide a strong foundation about various communication systems in practice.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamentals of amplitude and frequency modulation techniques.	Understand
CO2	Summarize the principle of operation of AM and FM transmitters and receivers.	Understand
CO3	Outline the principles of television and radar communication systems.	Understand
CO4	Explain the fundamentals of digital modulation techniques.	Understand
CO5	Outline the principles of cellular and satellite communication systems.	Understand

iv) SYLLABUS

AM and FM fundamentals - AM and FM transmitters and receivers - Television and radar systems - Digital communication systems - Satellite communication - Cellular telephone.

v) (a) TEXT BOOKS

1) Kennedy G., *Electronic Communication Systems*, McGraw-Hill, New York, 2008.
2) Roody and Coolen, *Electronic Communication*, Prentice Hall of India LTD., New Delhi, 2007.
3) Wayne Tomasi, *Electronic communication system fundamentals*, Pearson Education, 2003.
4) Behrouz A. Forouzan, *Data Communication and Networking* (Fourth Edition), Tata McGraw Hill, 2017.

(b) REFERENCES

1) William Scheweber, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.
2) Wayne Tomasi, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.
3) Frank R. Dungan, *Electronic Communication Systems*, 3/e, Vikas Publishing House, 2002.
4) Simon Haykins, *Communication Systems*, John Wiley, USA, 2006.
5) Bruce Carlson, *Communication Systems*, Tata McGraw Hill, New Delhi, 2001.

6) Taub and Schilling, *Principles of Communication Systems*, McGraw-Hill, New York, 2008.
7) Anokh Singh, *Principles of Communication Engineering*, S. Chand and Company Ltd., Delhi.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**AM and FM fundamentals-**AM – Frequency spectrum – vector representation – power relations – generation of AM – DSB, DSB/SC, SSB, VSB. FM – frequency spectrum – power relations.	**8**
II	**AM and FM transmitters and receivers-**Block diagrams of low power and high-power AM transmission - AM receivers: straight receivers super hetrodyne receiver - choice of intermediate frequency - simple AVC circuit - Block diagrams of direct FM transmitter and Armstrong transmitter -FM receivers (balanced -slope detector and Foster-Seely discriminator only).	**9**
III	**Television and radar systems**: Principles of television engineering - Requirements and standards – need for scanning - types of camera tubes and picture tubes - B/W and colour systems - PAL - CCTV - Cable TV-high-definition television. Radar and navigation: principle of radar and radar equation, block schematics of pulsed radar.	**9**
IV	**Digital communication**: Principles of digital communication –sampling process-pulse modulation Techniques- sampling process-PAM, PWM and PPM concepts - PCM encoder and decoder Applications of data communication.	**10**
V	**Cellular Communication-** Basic concepts, frequency reuse, interference cell splitting, sectoring, cell system layout, cell processing. Fibers – types: sources, detectors used, digital filters, optical link. **Satellite communication** Multiple access (MA) techniques-FDMA, TDMA, CDMA, SDMA applications in satellite communication. Earth station,	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42Y	INTERNET OF THINGS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) 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.

iii) COURSE OUTCOMES

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

CO1	Explain the role of computer networks in IoT.	Understand
CO2	Classify the different communication standards for IoT applications.	Understand
CO3	Explain the functionalities and applications of various sensors and transmit the data to cloud-based platforms.	Understand
CO4	Develop programs for IoT devices using micro-python language.	Apply
CO5	Develop an IoT based solution for real time applications.	Apply

iv) 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, 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. IoT Applications.

v) (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.

(b) REFERENCES

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

vi) 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).	**8**
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.	**9**
IV	**Embedded devices for IoT.** Introduction to Python programming and embedded programming using micropython. 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 micropython. (Assignments on hardware implementation using these or similar boards may be given.)	**8**
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.	**10**
	Total hours	**45**

ix) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

x) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42X	POWER QUALITY	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) 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.

iii) 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	Apply Fourier Transform concepts for harmonic analysis.	Apply
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

iv) 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, window function. Modeling of networks and components under non-sinusoidal conditions 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, EI Introduction Grounding and wiring.

v) (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.

vi) 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. **Harmonic analysis**: using Fourier series and Fourier transforms – simple numerical problems, Window function	9
III	**Modeling of networks and components under non-sinusoidal conditions-**transmission and distribution systems-shunt capacitors, electric machines. **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.	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. Electromagnetic Interference (EMI -introduction - Frequency Classification - Electrical Fields - Magnetic Fields - EMI Terminology - Power frequency fields. **Grounding and wiring**– reasons for grounding – wiring and grounding problems - solutions to these problems.	9
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42W	COMPUTER NETWORKS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

This course offers learners a comprehensive understanding of how computer networks are constructed, ranging from local area networks (LANs) to the vast, global Internet. It explores how these networks enable computers to share information and communicate effectively. The curriculum covers the physical components of computer networks, the layers of the OSI Reference Model, and principles of inter-networking. Additionally, learners will develop the skills to compare and evaluate existing network technologies, enabling them to select an optimal network design for specific systems.

iii) COURSE OUTCOMES

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

CO1	Explain the features of computer networks, network design models and the fundamental characteristics of the physical layer	Understand
CO2	Explain the design issues of data link layer, link layer protocols, bridges and switches	Understand
CO3	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11)	Understand
CO4	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network	Apply
CO5	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking	Understand

iv) SYLLABUS

Introduction - Reference Models - Physical Layer - Data link layer - Medium Access Control (MAC) sublayer - Wireless LANs - 802.11 -Network layer - Routing Algorithms- Congestion Control Algorithms - Quality of Service (QoS) - Network Layer in Internet - Transport Layer – User Datagram Protocol (UDP) - Transmission Control Protocol (TCP) – Application Layer protocols.

v) (a) TEXT BOOKS

7) Andrew S. Tanenbaum, *Computer Networks*, 4/e, PHI (Prentice Hall India).
8) Behrouz A Forouzan, *Data Communication and Networking*, 4/e, Tata McGraw Hill
9) Keshav, *An Engineering Approach to Computer Networks*, Addison Wesley, 1998.
10) Larry L Peterson and Bruce S Dave, *Computer Networks – A Systems Approach*, 5/e, Morgan Kaufmann.

(b) REFERENCES

1) Fred Halsall, *Computer Networking and the Internet*, 5/e.
2) James F. Kurose, Keith W. Ross, *Computer Networking: A Top-Down Approach*, 6/e.
3) W. Richard Stevens. *TCP/IP Illustrated* Volume 1, Addison-Wesley, 2005.
4) William Stallings, *Computer Networking with Internet Protocols*, Prentice-Hall, 2004

5) *Request for Comments (RFC) Pages* - IETF -https://www.ietf.org/rfc.html.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.	**9**
II	Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer – Channel allocation problem, Multiple access protocols Ethernet, Ethernet cabling, Manchester encoding, Ethernet MAC sublayer protocol, Binary Exponential Backoff algorithm. Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control. Wireless LANs -802.11, Bridges & switches, Repeaters, Hubs, Bridges, Switches, Routers and Gateways. (Basic concept only)	**10**
III	Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Multicast routing. General principles of congestion control, Congestion prevention policies, Congestion control algorithms. Load shedding, Jitter control. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.	**8**
IV	IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6	**9**
V	Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol (SNMP), World Wide Web (www) – Architectural overview.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42V	ENERGY MANAGEMENT AND AUDITING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) 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 energy auditing procedure and the different methods used for the economic analysis of energy projects.

iii) COURSE OUTCOMES

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

CO1	Explain the significance of energy management and auditing.	Understand
CO2	Identify energy efficiency improvement opportunities for electrical loads.	Apply
CO3	Explain various Demand Side Management techniques.	Understand
CO4	Explain the process of energy audit and the method of cogeneration.	Understand
CO5	Make use of various methods for economic energy analysis.	Apply

iv) SYLLABUS

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

Energy management in industries and commercial establishments-Energy conservation in boiler, 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.

Energy Audit- need, types and methodologies. Energy Economics: Economic analysis: methods. Computer aided Energy Management Systems.

v) (a) TEXT BOOKS

1) Albert Thumann, William J. Younger, *Handbook of Energy Audits*, 9th edition, Fairmont Press, 2012.
2) Charles M. Gottschalk, *Industrial energy conservation*, John Wiley & Sons, 1996.
3) Craig B. Smith, Kelly E Parmenter, *Energy management principles: Applications, Benefits, Savings*, 2nd edition, Pergamon Press, 2001.
4) D. Yogi Goswami, Frank Kreith, *Energy Management and Conservation Handbook*,2nd edition, CRC Press, 2007.

5) G.G. Rajan, *Optimizing energy efficiencies in industry*, Illustrated edition, Tata McGraw Hill, Pub. Co., 2001.

(b) REFERENCES

1) IEEE recommended practice for energy management in industrial and facilities.
2) IEEE std 739 - 1995 (Bronze book).
3) M Jayaraju and Premlet, *Introduction to Energy Conservation and Management*, 3rd edition, Phasor Books, 2008.
4) Paul O'Callaghan, *Energy managemen*t, 1st edition, McGraw Hill Book Co., 1993.
5) Wayne C. Turner, *Energy management Hand Book* - The Fairmount Press, Inc., 1997.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Energy Management:** General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling -Case studies. Energy efficiency methods for electrical utilities- energy efficient lighting and motors. Energy management opportunities in electrolytic process and electric heating, Case studies.	**9**
II	**Energy Management in Industries and Commercial Establishments**: Boiler - working principle - blow down, energy conservation opportunities in boiler. Steam: Properties of steam, distribution losses, steam trapping. Identifying opportunities for energy savings in steam distribution. Furnace- General fuel economy measures, energy conservation opportunities in furnaces. Heat Recovery Systems: Waste heat recovery system - Energy saving opportunities. Case studies related to industrial installations.	**10**
III	**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 techniques - peak clipping, peak shifting, valley filling. Strategic conservation, energy efficient equipment. Ancillary services- Introduction of ancillary services, Types of Ancillary services.	**10**
IV	**Energy audit**: Definition, Need, Types of energy audit. Pre-audit, audit and post audit phases-purpose and results. Energy audit Instruments – Energy audit report - format. 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, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS) – Block diagram.	**7**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Cate-gory	L	T	P	Credit	Year of Introduction
EE1U42U	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The aim of this subject is to offer the students a general understanding of various automotive electrical and electronic systems used in automobiles.

iii) COURSE OUTCOMES

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

CO1	Explain the various types of batteries used in automotive vehicles.	Understand
CO2	Outline the key components of charging system and the components and mechanisms of the starter system.	Understand
CO3	Explain the ignition systems and fuel injection systems in automotive vehicles.	Understand
CO4	Explain the components of automotive lighting systems and various instrumentation systems.	Understand
CO5	Summarize the various types of sensors and actuators used in automobiles.	Understand

iv) SYLLABUS

Principle of lead acid battery & constructional details-Capacity Rating, Battery charging methods, Battery tests. Developments in storage. Charging system: Working and constructional details of Alternators Starting system: Requirement of starter motor -Starter drive mechanisms. Battery coil and Magneto ignition system, Centrifugal and Vacuum advance mechanisms, Spark plugs, constructional details and types. Electronically assisted ignition system; Non-contact triggering devices - Electronic fuel injection system overview. Lighting, Instrumentation types -Sensors and applications in Automobile, Actuators. Introduction to internet of things (IOT) and its automotive applications.

v) (a) TEXT BOOKS

1) Kohli.P.L. *Automotive Electrical Equipment*, Tata McGraw-Hill Co Ltd,1st Edition, 2009.
2) Tom Denton, *Automobile Electrical and Electronic Systems*, Elsevier Butterworth-Heinemann, 3rdEdition, 2004.

(b) REFERENCES

1) A I Santini, *Automotive Electricity and Electronics, Cengage Learning*, AUTOMOBILE ENGINEERING, 2013
2) Robert Bosch, *Automotive Handbook*, Bently Publishers, 1st Edition, 2004.
3) William B. Ribbens, Norman P. Mansour, *Understanding automotive electronics*, Newnes, 6th Edition, 2003.

4) Jim Horner, *Automotive Electrical HandBook*, Penguin, 1986
5) Barry Hollembeak, *Automotive Electricity & Electronics, Cengage Learning*,5th Edition 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Batteries:** Principle of lead acid battery & constructional details, Effect of temperature on electrolyte, Capacity Rating, Battery charging methods, Battery tests. Developments in storage: Nickel metal hydride battery, Lithium-ion battery, Fuel cells, Ultra capacitors.	9
II	**Charging system:** Working of three phase Alternators, Rectification, voltage regulation, current regulation. **Starting system:** Requirement of starter motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starting circuit, Starter Switches.	9
III	**Battery coil and Magneto ignition system**: Centrifugal and Vacuum advance mechanisms, Spark plugs - constructional details and types. Electronically assisted ignition system, Non-contact triggering devices - Fully electronic ignition System, Distributorless ignition. **Electronic fuel injection system overview:** D jetronic, K jetronic and L jetronic fuel injection; Injections schemes – Single point, Multi point, Sequential, Direct injection, Common rail direct injection, Gasoline direct injection, Supercritical injection.	9
IV	**Lighting:** Types of headlights, headlight reflectors, headlight lenses, indicator lamp details, lighting circuit, projector headlights; Horn and wiper mechanisms. **Instrumentation:** Speedometer, Fuel Level Indicator, Oil Pressure and Coolant Temperature Indicators, Display devices – LED, LCD, Onboard diagnostics (OBD), OBD – II	9
V	**Sensors and applications in Automobile**: Pressure sensors, Temperature sensors, Position sensors, Lambda sensor, Air flow sensor, Wheel speed sensor, Knock sensor, Optical sensors. **Actuators:** Solenoids, Stepper motors, Relays, Piezoelectric. Introduction to internet of things (IOT) and its automotive applications.	9
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U42T	DIGITAL CONTROL SYSTEMS	PEC	2	1	0	3	2022

i) **PRE-REQUISITE:** EE1U20A: Circuits and Networks, EE1U30C: Signals and Systems, EE1U30E: Linear Control Systems.

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

iii) **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.	Understand
CO2	Use 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.	Analyse

iv) **SYLLABUS**

Basic digital control system - Mathematical modelling - sampling and reconstruction - Zero order and First order hold circuits - realisation 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, Design of controllers and compensators by the method of Ragazzini - 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.

v) **(a) TEXT BOOKS**

1) C. L. Philips, H. T. Nagle, *Digital Control Systems*, Prentice-Hall, Englewood Cliffs, New Jersey, 1995.
2) M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw-Hill, 1997.

3) Ogata K., *Discrete-Time Control Systems*, Pearson Education, 2nd Edition, 2005.

(b) REFERENCES

1) Benjamin C. Kuo, *Digital Control Systems*, 2nd Edition, Saunders College Publishing, Philadelphia, 1992.
2) Constantine H. Houpis and Gary B. Lamont, *Digital Control Systems Theory*, Hardware Software, McGraw Hill Book Company, 1985.
3) Isermann R., *Digital Control Systems: Fundamentals, Deterministic Control*, V. I, 2nd Edition, Springer Verlag, 1989.
4) Liegh J. R., *Applied Digital Control Theory, Design and Implementation*, Dover Publishers, 2nd Ed. ISBN13-978-0486450513
5) Åström, Karl J., and Björn Wittenmark, *Computer-controlled systems: Theory and design*, Courier Corporation, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Basic digital control system- Mathematical modeling - sampling and reconstruction - Zero order and First order hold circuits - realisation 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.	**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, lead and lag-lead compensator using root locus - Design of controllers and compensators by the method of Ragazzini- Dead beat response controller introduction.	**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. Digital controller and observer design - state feedback – pole placement - full order observer - reduced order observer.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

PROGRAMME ELECTIVE V

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43Z	SWITCHED MODE POWER CONVERTERS	PEC	3	0	0	3	2022

vii) PRE-REQUISITE: EE1U30G: Power Electronics

viii) COURSE OVERVIEW: Goal of this course is to expose the students to the analysis of different non-isolated, isolated DC-DC converters. It gives an insight to the design of DC-DC converters. It also includes the different PWM techniques of DC- AC converters and the concepts of Resonant converters.

ix) COURSE OUTCOMES

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

CO1	Compare the different non-isolated and isolated DC-DC converter topologies.	Understand
CO2	Model the different non-isolated and isolated DC-DC converter topologies.	Apply
CO3	Explain the operation of Switched mode inverters and rectifiers.	Understand
CO4	Summarize the different inverter modulation strategies.	Understand
CO5	Explain the operation of soft switching resonant converters.	Understand

x) SYLLABUS

Linear power supply, Switched mode power supply, DC-DC convertors without isolation – buck, boost, buck boost.
Discontinuous conduction mode of dc-dc converter, Cuk converter, Full bridge dc-dc converter.
DC-DC converters with isolation – Flyback converter, Forward converter, Push Pull-Half Bridge, Full Bridge converter, current source converter.
Switched mode DC-AC converter – single phase inverter, three phase inverter, Sine Pulse width modulation – unipolar and bipolar switching.
Resonant converters – Series resonant converter, parallel resonant converter, load resonant converter, Zero Voltage Switching, Zero current switching.

xi) (a) TEXT BOOKS

1) Ned Mohan, Tore M. Undeland, William P. Robbins, *Power Electronics Converters, Applications, and Design*, 3rd Edition, Wiley India Pvt Ltd, 2018.
2) Rashid M H, *Power Electronics – Circuits, Devices and Applications, Prentice Hall of India*, New Delhi, 4th edition, 2014.
3) Taylor Morey, Abraham Pressman, Keith Billings, *Switching Power Supply Design*, McGraw Hill, 3rd Edition, 2009.

(b) REFERENCES

1) Daniel W Hart, *Power Electronics*, Tata McGraw Hill, 2011.

2) Umanand L, *Power Electronics- Essentials and Applications*, Wiley 2011
3) Christophe P. Basso, *Switch-Mode Power Supplies Spice Simulations and Practical Designs* BPB Publication, 2010.
4) Muhammad Rashid, *Digital Power Electronics and Applications*, first edition, Elsevier, 2005.
5) Christophe Basso, *Switch-Mode Power Supplies, SPICE Simulations and Practical Designs*, Second Edition 2014

xii) COURSE PLAN

Module	Contents	No. of hours
I	**Linear vs Switching Power Electronics** Buck, Boost, Buck-boost and Ćuk converters: Principles of steady-state analysis - Inductor volt-seconds balance and capacitor amp-seconds balance – Operation in Continuous Conduction Mode (CCM)- Voltage Gain – design of filter inductance & capacitance - boundary between continuous and discontinuous conduction – critical values of inductance/load resistance - Examples for buck and boost converters. Discontinuous Conduction Mode (DCM) of buck converter with constant output voltage – Output voltage ripple in DCM. Voltage Gain in DCM for buck converters. Synchronous Buck Converter.	9
II	**DC-DC converters with electrical isolation** High-frequency transformers for DC-DC converters: unidirectional magnetic core excitation & bidirectional core excitation. Fly back converter: Operation and waveforms in continuous & discontinuous conduction modes – Voltage gain. CCM operation of double ended fly-back converter. Forward converter in CCM: Basic forward converter with ideal transformer – practical forward converter with core reset – double ended forward converter Push-Pull, Half-Bridge and Full-Bridge converters: Operation in Continuous Conduction Mode (CCM) – Flux-walking in isolated converters. Current-source DC-DC converter.	9
III	**Switched Mode DC to AC converters** Review of single-phase bridge inverters - 3-phase Sine-PWM inverter: – Linear Modulation, RMS, fundamental line to line voltage – Overmodulation - Square wave operation in three-phase inverters - Switch utilisation ratio of 1-phase & 3-phase full-bridge inverters. PWM Rectifiers: Generation of current harmonics in diode bridge rectifiers - Power factor - Single phase Switched mode rectifier.	9
IV	**Modulation Schemes** Space Vector Modulation: Concept of space vector – space vector modulation – reference vector & switching (dwell) times – space vector sequence – comparison of sine PWM & space vector PWM.	9

	Programmed (selective) harmonic elimination switching in single phase inverters (Formulation example with elimination of two harmonics at a time) – current controlled voltage source inverter - Hysteresis current control.	
V	**Soft switching and resonant converters** Hard-switched Vs Soft-switched converters - Resonant Converters - Basic resonant circuit concepts – series resonant circuit – parallel resonant circuit – series-loaded and parallel loaded resonant converters (Operation in discontinuous conduction mode with $\omega s < 0.5\ \omega r$). Resonant Switch (Quasi-resonant) Converters: ZCS buck converter - L type - ZVS buck converter – comparison of ZCS & ZVS Resonant Converters.	**9**
	Total hours	**45**

ix) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

x) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43Y	INDUSTRIAL INSTRUMENTATION AND AUTOMATION	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course introduces basic terms and techniques applicable to instrumentation and various automation activities related to the industry and power sector. It also provides a basic idea of the recent developments in communication techniques and process control in industrial automation.

iii) COURSE OUTCOMES

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

CO1	Interpret the sensors/transducers suitable for industrial applications.	Understand
CO2	Explain the signal conditioning circuits for industrial instrumentation and automation.	Understand
CO3	Illustrate the concepts of data transmission and virtual instrumentation related to automation	Understand
CO4	Develop the ladder logic for the process control applications using PLC programming	Apply
CO5	Explain the fundamental concepts of DCS and SCADA systems	Understand

iv) SYLLABUS

Sensors and Transducers: Process Control - block diagram of the process control loop, definition of elements. Sensor time response - first and second-order responses. Transducers- Characteristics and Choice of the transducer, Applications of Transducers.

Signal conditioning circuits and Final control: Electronic amplifiers, Final control operation- signal conversion- actuators- control elements, Actuators- Electrical – Pneumatic- Hydraulic, Control elements – mechanical – electrical – fluid valves.

Data transmission and Virtual instrumentation system: Cable transmission of analog and digital data, Fiber optic data transmission, Pneumatic transmission. Process control Network. Virtual instrumentation system.

Programmable logic controllers (PLC): Programmable logic controllers, Standards Programming aspects- Ladder programming- realization of AND, OR logic, the concept of latching.

SCADA Architecture, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Protocols- DCS: Introduction, DCS Architecture, Control modes.

iv) (a) TEXT BOOKS

1) Curtis D Johnson, *Process Control Instrumentation Technology*, PHI Learning Pvt Ltd New Delhi, 1997

2) Doeblin E.O, *Measurement Systems: Application and Design*, Fourth Edition, McGraw Hill, Newyork, 1992
3) DVS. Murty, *Transducers and Instrumentation*, Second Edition, PHI Learning Pvt Ltd New Delhi, 2013
4) Jovitha Jerome, *Virtual instrumentation using LabVIEW*, Prentice Hall of India, 2010.
5) William Bolton, *Programmable Logic Controllers*, Fifth edition, ELSEVIER INDIA Pvt Ltd New Delhi, 2011
6) Stuart A. Boyer, *SCADA: Supervisory Control and Data Acquisition*, Fourth edition, International Society of Automation, 2010

(b) REFERENCES

1) G.K.McMillan, *Process/Industrial Instrument and control and hand book*, McGraw Hill, New York, 1999.
2) Michael P. Lucas, *Distributed Control system*, Van Nastrant Reinhold Company, New York.
3) Patranabis, D., *Principles of Industrial Instrumentation*, Second Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
4) Robert B. Northrop, *Introduction to instrumentation and measurements*, CRC, Taylor and Francis, 2005.
5) Gary B. Lamont, *Digital Control systems*, McGraw Hill Book Company, Singapore, 1985.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Sensors and Transducers:** Introduction to Process Control - block diagram of the process control loop. Sensor time response - first and second-order responses. **Transducers:** Transducers, sensors, classification of transducers – characteristics - transducer output characteristics - choice of transducers. **Applications of Transducers:** Displacement measurement using Resistance Potentiometer - Capacitive differential pressure measurement, Flow measurement using Hotwire anemometer. Speed measurement- Variable reluctance tachometers.	**10**
II	**Signal conditioning circuits:** Electronic amplifiers- Instrumentation Amplifiers, Log amplifiers, Isolation Amplifiers, Charge amplifiers, Phase-sensitive detectors. **Final control:** Signal converters **-** P to I converter, I to P converter. Actuator – electrical, pneumatic, hydraulic. Control valve – characteristics - quick opening, linear, equal percentage- Valve types and functioning – solenoid valve - electric motor actuated control valve - selection of a control valve.	**9**

III	**Data transmission and Virtual instrumentation system:** Transmission Media - unguided and guided media, wired and wireless, UTP, coaxial and fibre optical cable. Fiber optic data transmission, Pneumatic transmission. Process control Network- Characteristics of Communication Networks - Fieldbus and Profibus, radio-wireless communication - WLAN architecture. **Virtual instrumentation system:** Virtual Instrumentation - Definition and Flexibility - Block diagram and Architecture - Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - Graphical Programming Environment in Virtual Instrumentation.	**9**
IV	**Programmable logic controllers (PLC):** Programmable logic controllers- Organization- Hardware details- I/O- Power supply- CPU- Standards Programming aspects- Ladder programming- realization of AND, OR logic, the concept of latching, Introduction to Timer/Counters, Exercises based on Timers and Counters.	**9**
V	**SCADA:** Introduction, SCADA Architecture, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Trends in SCADA, Security Issues. Different Communication Protocols- IEC 60870-5-101 and DNP3. **DCS:** Introduction, DCS Architecture, Control modes- DCS versus SCADA terminology- DCS integration with PLC and Computers- Features and Advantages.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43X	VR AND AR FOR ASSISTIVE TECHNOLOGY	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

This course explores the intersection of Virtual Reality (VR), Augmented Reality (AR), and assistive technologies to empower individuals with disabilities and enhance their quality of life. Students will gain hands-on experience and theoretical knowledge to develop innovative solutions leveraging immersive technologies to overcome physical, cognitive, and sensory challenges.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamental concepts of AR and VR, including key components of AR/VR systems.	Understand
CO2	Develop basic AR and VR applications using industry-standard tools.	Apply
CO3	Explain the principles of human-centered design and accessibility in AR/VR applications.	Understand
CO4	Explain the applications of AR and VR in assistive technology, including navigation assistance, rehabilitation, and cognitive support.	Understand
CO5	Summarize the ethical, social, and industrial aspects of AR and VR, including privacy, legal frameworks, and future challenges.	Understand

iv) SYLLABUS

Introduction to AR and VR: Definitions, Concepts, and History. Hardware and Software, Basics of 3D Graphics and Visualization - Overview of AR/VR Applications in Various Domains. Introduction to Development Platforms, Basic Programming for AR and VR Applications. Applications of AR and VR in Assistive Technology. Ethical and Privacy Considerations in AR/VR, Legal and Regulatory Frameworks for AR/VR, AR and VR in Industry and Healthcare.

v) (a) TEXT BOOKS

1) Schmalstieg and T. Hollerer, *Augmented Reality: Principles and Practice*, Addison-Wesley, 2016.
2) T. Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile*, O'Reilly Media, 2015.
3) J. Jerald, *The VR Book: Human-Centered Design for Virtual Reality*, ACM Books, 2015.
4) R. Riener and M. Harders, *Virtual Reality in Medicine*, Springer, 2012.
5) W. R. Sherman and A. B. Craig, *Understanding Virtual Reality: Interface, Application, and Design*, Morgan Kaufmann, 2018.

(b) REFERENCES

1) S. Aukstakalnis, *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR*, Addison-Wesley, 2017.
2) J. Linowes, *Unity Virtual Reality Projects*, Packt Publishing, 2018.
3) J. Donally, *The Immersive Classroom: Create Customized Learning Experiences with AR/VR Technology*, ISTE, 2021.
4) M. Augstein and W. Ortner, *Augmented Reality: Reflections on Its Contribution to Knowledge Formation*, Springer, 2023.
5) A. B. Craig, *Understanding Augmented Reality: Concepts and Applications*, Morgan Kaufmann, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of AR and VR** - Introduction to AR and VR: Definitions, Concepts, and History - Differences between AR, VR, and Mixed Reality (MR) - Components of AR and VR Systems - **Hardware:** Sensors, Cameras, Displays, Controllers, Haptic Devices - **Software:** AR/VR SDKs and Platforms (e.g., Unity, Unreal Engine) - **Basics of 3D Graphics and Visualization -** Overview of AR/VR Applications in Various Domains.	**8**
II	**Tools and Technologies for AR and VR Development** - Introduction to Development Platforms - Unity: Basics and AR/VR Integration - Unreal Engine for VR Applications - Overview of **AR SDKs** (e.g : ARCore, ARKit) - Understanding Head-Mounted Displays (HMDs) and Mobile-Based AR/VR - **Basic Programming for AR and VR Applications** - (e.g : Python & C#) Introduction to 3D Modeling Tools (e.g : Blender) .	**10**
III	**Human-Centered Design and Assistive Technology** - Principles of Human-Centered Design for AR and VR - Understanding Accessibility and Usability in AR/VR Applications - AR/VR for Physical Disabilities: Applications and Case Studies - AR/VR for Cognitive Disabilities: Immersive Learning and Therapy - Ethical Considerations in Designing Assistive Technologies.	**9**
IV	**Applications of AR and VR in Assistive Technology** - AR for Navigation Assistance: Indoor and Outdoor Navigation for the Visually Impaired - VR for Rehabilitation and Therapy: The science behind VR-based motor skill recovery, Psychological and cognitive benefits of VR therapy Limitations and ethical concerns in VR rehabilitation. Haptic Feedback Devices and Their Integration with AR/VR Systems. Cognitive and Learning Support with AR/VR. Future Trends and Challenges in AR/VR Assistive Technology.	**10**

V	**Ethical, Social, and Industrial Aspects of AR and VR - E**thical and Privacy Considerations in AR/VR, Legal and Regulatory Frameworks for AR/VR, AR and VR in Industry and Healthcare, Human-Computer Interaction and User Experience in AR/VR, The Future of AR and VR: Possibilities and Challenges.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Cate-gory	L	T	P	Credit	Year of Introduction
EE1U43W	ELECTRICAL SYSTEM DESIGN FOR INDUSTRY AND INFRASTRUCTURE	PEC	2	1	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course provides a comprehensive understanding of electrical system design for residential buildings, covering fundamental concepts, standards, and practical applications. The course emphasizes safe, efficient, and code-compliant electrical installations while integrating modern energy-efficient and smart home technologies.

iii) COURSE OUTCOMES

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

CO1	Design efficient outdoor lighting systems for industrial applications	Apply
CO2	Explain the purpose of various protective devices and cables for Motor loads and its selection criteria.	Understand
CO3	Develop the single line diagram of 11kV indoor transformer substation with light and power loads in an industry.	Apply
CO4	Design the earthing system for a 11kV substation.	Apply
CO5	Explain the components and selection criteria of backup power supply.	Understand
CO6	Illustrate the various energy saving methodologies and renewable energy integration in industrial installations	Understand

iv) SYLLABUS

Industrial Lighting systems: Importance of proper lighting in industrial installations- Exterior lighting design- Flood Lighting General Aspects of emergency lighting.

Industrial installations: Classification - Design of electrical distribution systems with main switch board, sub switch boards and distribution boards -selection of bus bars and switchgears. Selection of 11kV indoor transformer substations upto 500kVA.

Short circuit calculations and earthing design for the HV and LV sides of an 11 kV substation. Lightning protection system for industrial building.

Selection of standby Diesel Generator set (DG set) Energy Conservation Techniques in electrical power distribution.

Integration of renewable energy: Solar and wind power integration- Hybrid renewable energy utility systems for industrial sites.

v) (a) TEXT BOOKS

1) S. K. Bhattacharya, K. B. Raina, *Electrical Design Estimating and Costing*, New Age International Publishers, 3rd Edition, 2024.
2) Theodore R Bosela, *Electrical Systems Design*, Prentice Hall, 1st edition, 2002.
3) J.B. Gupta, *Course in Electrical Installation Estimating & Costing*, S. K. Kataria & Sons, 9th edition, 2012.
4) M. K. Giridharan, *Electrical Systems Design*, I K International Publishers, New Delhi, 2nd edition, 2016.
5) Steven J. Marrano, *Electrical System Design and Specification Handbook for Industrial Facilities*, Fairmont Press, 1998.

(b) REFERENCES

1) *Electrical Installation Design Guide: Calculations for Electricians and Designers*, The Institution of Engineering and Technology (IET), 5th edition, 2022.
2) U.A. Bakshi, V.U. Bakshi, *Electrical Technology*, Technical publications, Pune, 1st Edition, 2020.
3) IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
4) V. K. Jain & Amitabh Bajaj, *Design of Electrical Installations*, Lakshmi Publications Pvt. Ltd., 2nd edition 2012.

Data Book (Approved for use in the examination):

1) M K Giridharan, *Electrical Systems Design Data Hand book*, I K International Publishers.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Industrial Lighting systems:** Importance of proper lighting in industrial installations- Overview of lighting principles (luminance, illuminance, glare, color temperature, CRI). **Exterior lighting design**- point to point method - road lighting and public area lighting- Space to mounting height ratio - selection of luminaires – Working principle of Metal Halide - High & Lows pressure Sodium vapour lamps. **Flood Lighting:** Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp, projector and their arrangement.	**8**
II	**Industrial installations:** Industrial buildings classification - Overview of IEC, IEEE standards in industrial systems- Industrial power distribution architecture Industrial loads - motors, starting of motors - Introduction to PCC, MCC panels. Specifications of LT Breakers - Motor wiring diagram. Selection of armoured power cables (AYFY, A2XFY, YWY) – calculation of ampacity, cable voltage drop calculation, short circuit withstand capacity.	**8**

III	**Design of Industrial Installation:** 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 - Selection of transformer substations, switchgears and protective devices **Substations:** Classification –components of indoor and outdoor substations- single line diagram - Design of indoor 11kV substations up to 500kVA.	**10**
IV	**Substation earthing:** Earth Mat, Earthing electrode, Grounding conductors, Neutral Grounding system. **Short circuit calculations:** Short circuit calculations and earthing design for the HV and LV sides of a 11 kV substation – Pre-commissioning tests of 11kV indoor/outdoor substation Lightning protection system for industrial building - role of grounding in lightning protection systems – safety aspects.	**10**
V	**Standby power supply:** Selection of standby Diesel Generator set (DG set) - Power rating- Continuous, Prime and Standby power ratings- installation and essential Protections-Introduction to Automatic Mains failure (AMF) systems. Automatic Power Factor Correction (APFC) panel. **Energy Conservation Techniques** in industrial power distribution - Lighting automation and controls (DALI, sensors, daylight harvesting) Integration of renewable energy: Solar and wind power integration- Hybrid renewable energy utility systems for industrial sites.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43V	COMPUTER AIDED POWER SYSTEM ANALYSIS	PEC	2	1	0	3	2022

i) **PRE-REQUISITE:** EE1U30A: Power Systems I

ii) **COURSE OVERVIEW**: The basic objective of this course is to familiarize the efficient computational techniques applied in analyzing the power system

iii) **COURSE OUTCOMES**

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

CO1	Develop the model of power system networks.	Apply
CO2	Solve linear systems using computationally efficient methods.	Apply
CO3	Solve load flow problems in power systems.	Apply
CO4	Develop optimal power flow problem in power system networks.	Apply
CO5	Analyze power system under short circuit conditions and infer the results to design a protective system.	Analyze

iv) **SYLLABUS**

Overview of graph theory: tree, co-tree and bus incidence matrix, development of network matrices from graph theoretic approach. Building algorithm for bus impedance matrix.

Review of solution of equations by Gauss-Jordan method, Gauss elimination, and LDU factorization. Inversion of Y bus for large systems.

Review of Load Flow analysis, Newton-Raphson method, Fast Decoupled Load Flow and DC Load Flow.

Review of economic load dispatch, formulation of optimal power flow with active power cost minimization, Solution of OPF using Gradient and Newton's methods.

Network fault calculations using Z bus, algorithm for calculating system conditions after fault – three phase to ground fault.

v) **(a) TEXT BOOKS**

1) D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, Tata McGraw-Hill Education, 2003.
2) J. J. Grainger and W. D. Stevenson, Jr., *Power System Analysis*, McGraw-Hill International Edition, 1994.
3) T.K. Nagsarkar and M.S. Sukhija, *Power System Analysis*, Oxford University Press, 2016.
4) G.W. Stagg & A.H. El-Abiad, *Computer Methods in Power System Analysis*, Tata McGraw-Hill Education, 1968.
5) Arriliga J and Watson N R, *Computer Modeling of Electrical Power Systems*, Wiley, 2nd edition, 2001.

(b) REFERENCES

1) L. P. Singh, *Advanced Power System Analysis and Dynamics*, 3rd Edition, New Age Intl, 1996.
2) M. A. Pai, *Computer Techniques in Power Systems Analysis*, Tata McGraw-Hill, 2nd Edition, 2005.
3) Arthur R. Bergen, Vijay Vittal, *Power Systems Analysis*, 2nd Edition, Pearson Higher Education.
4) Wood, Allen J., Bruce F. Wollenberg, and Gerald B. Sheblé. *Power generation, operation, and control*, John Wiley & Sons, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Network Equation, Concept of Linear Graph – tree, co-tree, Bus Incidence matrix, A. Formation of Y_{bus} and Z_{bus} by singular transformation, Numerical problem. Z_{bus} building algorithm without mutual coupling (derivation not required), Numerical example.	**9**
II	Solution of linear system of equations by Gauss Jordan method and Gauss elimination method, Numerical problems. Triangular factorization –LDU factors, Numerical problems. Inversion of the Y_{BUS} matrix for large systems, Numerical problems. Tinney's Optimally Ordering.	**9**
III	Review of Load Flow analysis - Newton-Raphson method (Qualitative analysis only) - Fast Decoupled Load Flow (Numerical problems up to 2 iterations)- DC Load Flow (Numerical problems up to 2 iterations)	**9**
IV	Review of Economic Load Dispatch - Economic dispatch of generation without and with transmission line losses. Concept of optimal power flow – formulation with equality and inequality constraints (with active power cost minimization). Solution of OPF using Gradient and Newton method (Qualitative analysis only). Security Constrained Optimal Power Flow (concept only).	**9**
V	Symmetrical and Unsymmetrical fault calculations using Z_{BUS} – Numerical Problems (Symmetrical faults up to 3 bus systems). Algorithm for SC calculations for balanced 3 phase network – three phase to ground fault only – Numerical problems.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43U	FUNDAMENTALS OF NANOTECHNOLOGY	PEC	3	0	0	3	2022

i) PRE-REQUISITE:

ii) COURSE OVERVIEW: This course introduces students to the basics of nanotechnology, its applications, and its significance in modern science and engineering. By the end of the course, students should be able to understand the fundamental principles of nanotechnology and its interdisciplinary applications in various fields such as materials science, electronics, medicine, and energy.

iii) COURSE OUTCOMES

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

CO1	Explain the basic principles and concepts of nanotechnology.	Understand
CO2	Interpret and explain the different nanomaterials, their properties, and applications.	Understand
CO3	Explain the impact of nanotechnology on various industries, especially in electronics, medicine, and energy.	Understand
CO4	Outline the various fabrication and characterization techniques used in nanotechnology.	Understand
CO5	Explain the ethical, environmental, and safety considerations involved in the use of nanotechnology	Understand

iv) SYLLABUS

Introduction to Nanotechnology: Definition and scope, Historical overview and evolution, Size-dependent properties at the nanoscale. Classification of nanomaterials, Nanotechnology in nature (biomimetics).

Nanomaterials and Their Properties: Types of nanomaterials. Nanomaterials and their unique properties. Carbon-based nanomaterials.

Fabrication and Synthesis Techniques in Nanotechnology: Bottom-up and Top-down approaches. Chemical Vapor Deposition (CVD), Sol-Gel process, Atomic Layer Deposition (ALD), and Electrospinning. Lithography and Nanoimprint Lithography. Nanostructure formation and self-assembly techniques.

Characterization Techniques for Nanomaterials: Microscopy techniques. Spectroscopy. Surface analysis techniques.

Applications, Safety, and Future of Nanotechnology: Applications of nanotechnology in medicine, energy, and materials science. Environmental, health, and safety issues. Ethical considerations. Future directions and emerging trends in nanotechnology.

v) (a) TEXT BOOKS

1) Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, and Anil Rao, *Introduction to Nanoscience and Nanotechnology*, 2nd Edition, CRC Press, 2016.

2) Guozhong Cao and Ying Wang, *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, 2nd Edition, World Scientific Publishing, 2011.
3) Charles P. Poole Jr. and Frank J. Owens, *Introduction to Nanotechnology*, 1st Edition, Wiley-Interscience, 2003.
4) Dieter Vollath, *Characterization of Nanostructures*, 1st Edition, Wiley-VCH, 2008.
5) Mark Ratner and Daniel Ratner, *Nanotechnology: A Gentle Introduction to the Next Big Idea*, 1st Edition, Prentice Hall, 2003.

(b) REFERENCES

1) Sulabha K. Kulkarni, *Nanotechnology: Principles and Practices*, 3rd Edition, Springer, 2014.
2) Gabor L. Hornyak, Joydeep Dutta, H.F. Tibbals, Anil Rao, *Introduction to Nanoscience*, 1st or 2nd edition, CRC Press, 2008.
3) Stephen D. Senturia, *Microsystem Design*, 1st Edition, Springer, 2001.
4) Robert D. Braun, *Introduction to Instrumental Analysis*, International Edition, McGraw-Hill.
5) Yang Leng, *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*, 2nd Edition, Wiley, 2013.
6) Baldev Raj, Marcel Van de Voorde, Yashwant Mahajan, *Nanotechnology in the Energy Sector*, 1st Edition, Wiley-VCH, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Nanotechnology:** Definition and scope of nanotechnology**.** Historical overview and evolution of nanotechnology**.** Size-dependent properties at the nanoscale**.** Classification of nanomaterials: 0D, 1D, 2D, 3D**.** Nanotechnology in nature (biomimetics).	**8**
II	**Nanomaterials and Their Properties:** Types of nanomaterials: nanoparticles, nanotubes, nanowires, nanoplates, and nanofilms**.** Physical, chemical, optical, and mechanical properties of nanomaterials**.** Nanomaterials and their unique properties: surface area, quantum effects, and self-assembly**.** Carbon-based nanomaterials (Fullerenes, Graphene, Carbon nanotubes).	**9**
III	**Fabrication and Synthesis Techniques in Nanotechnology:** Bottom-up and Top-down approaches to nanofabrication**.** Chemical Vapor Deposition (CVD), Sol-Gel process, Atomic Layer Deposition (ALD), and Electrospinning**.** Lithography and Nanoimprint Lithography**.** Nanostructure formation and self-assembly techniques.	**9**

IV	**Characterization Techniques for Nanomaterials:** Microscopy techniques: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscopy (AFM)**.** Spectroscopy: X-ray Diffraction (XRD), Raman Spectroscopy, UV-Vis Spectroscopy**.** Surface analysis techniques: BET Surface Area Analysis, X-ray Photoelectron Spectroscopy (XPS).	**10**
V	**Applications, Safety, and Future of Nanotechnology:** Applications of nanotechnology in medicine (drug delivery, diagnostics, imaging), electronics (nanoelectronics, sensors), energy (solar cells, batteries, fuel cells), and materials science (nanocomposites)**.** Environmental, health, and safety issues in nanotechnology**.** Ethical considerations in nanotechnology development**.** Future directions and emerging trends in nanotechnology.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U43T	ENERGY STORAGE SYSTEMS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course is to expose the students to the fundamental concepts of energy storage systems used in different applications.

iii) COURSE OUTCOMES

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

CO1	Interpret the role of energy storage in power systems.	Understand
CO2	Classify thermal, kinetic and potential storage technologies and their applications.	Understand
CO3	Compare Electrochemical, Electrostatic and Electromagnetic storage technologies.	Understand
CO4	Apply energy storage technology in renewable energy integration.	Apply
CO5	Illustrate energy storage technology applications for smart grids.	Understand

iv) SYLLABUS

Introduction to energy storage in power systems- General considerations
Overview on Energy storage technologies - Thermal energy, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical- Flywheel, Power to Gas
Overview on Energy storage technologies- Batteries- Parameters, Fuel cells, Electrostatic energy Electromagnetic energy, Comparative analysis, Environmental impacts.
Energy storage and renewable power sources- Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated and integrated power systems with renewable power sources.
Energy storage Applications - Smart grid, Smart house, Mobile storage system- Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Hybrid energy storage systems.

v) (a) TEXT BOOKS

1) Osaka T., Datta M., *Energy Storage Systems in Electronics-New Trends in Electrochemical Technology*, CRC Press 2000.
2) Rand D.A.J., Moseley P.T., Garche J. and Parker C.D., Valve regulated Lead–Acid Batteries, Elsevier 2004.

(b) REFERENCES

1) Broussely M. and Pistoia G., *Industrial Applications of Batteries from Cars to Aerospace and Energy Storage*, Elsevier, 2007
2) Nazri G. A. and Pistoia G., *Lithium Batteries – Science and Technology*, Kluwer Academic Publishers, 2004.

3) Larminie J., Dicks A. and Wiley-Blackwell, *Fuel Cell Systems Explained*, 2nd Edition, Wiley Publications, 2013.

i) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to energy storage in power systems:** Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, comparison of storages and applications, Energy storage in the power and transportation sectors. Energy storage systems in electric vehicles, Electric vehicle market scenario. Need and role of energy storage systems in power systems, General considerations, Energy and power balance in a storage unit.	**9**
II	**Overview on Energy storage technologies:** Thermal energy: General considerations - Storage media- Containment- Thermal energy storage in a power plant, Potential energy: Pumped Hydro- Compressed Air, Kinetic energy: Mechanical - Flywheel, Power to Gas - Hydrogen - Synthetic methane	**9**
III	**Electrochemical and Electromagnetic Energy storage technologies:** Electrochemical energy -Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	**9**
IV	**Energy storage and renewable power sources:** Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources.	**8**
V	**Energy storage Applications:** Smart grid, Smart microgrid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems - Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Hybrid energy storage systems: configurations and applications.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

PROGRAMME ELECTIVE VI

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44A	ELECTRIC AND HYBRID VEHICLES	PEC	3	0	0	3	2022

i) PRE-REQUISITE: DC Machines and Transformers (EE1U20D), Power Electronics (EE1U30G), Synchronous and Induction machines (EE1U30D)

ii) COURSE OVERVIEW: The primary objective of this course is to familiarize students with the fundamental principles and emerging trends in electric, hybrid, and autonomous vehicles. It will cover the electric machines employed, their control strategies for EV applications, diverse charging infrastructure, and relevant communication protocols.

iii) COURSE OUTCOMES

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

CO1	Apply hybrid electric vehicle principle to determine the vehicle performance.	Apply
CO2	Illustrate the basic concepts and compare various configurations of Electric and Hybrid Electric drive trains	Understand
CO3	Explain the propulsion unit for electric and hybrid vehicles	Understand
CO4	Outline proper energy storage systems for vehicle applications	Understand
CO5	Infer various communication protocols and technologies used in vehicle networks	Understand

iv) 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, Induction Motor drives, PM and SRM motor drives.
Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, fuel cell, flywheel and supercapacitor-based energy storage.
Communication Systems, Energy Management Strategies, EV charging technologies and policies.

v) (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.

(c) ONLINE RESOURCES

1) NPTEL courses/Materials (IITG, IITM,IITD) – Electric and Hybrid vehicles
https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)
https://nptel.ac.in/courses/108/106/108106170/ (IIT Madras)
2) FOC Control - video lecture by Texas Instruments
https://training.ti.com/kr/field-oriented-control-permanent-magnet-motors
3) Sensored and sensorless FOC control of PMSM motors – Application notes (TI, MATLAB)
https://www.ti.com/lit/an/sprabz0/sprabz0.pdf?ts=1620018267996&ref_url=https%253A%252F%252Fwww.google.com%252F
https://in.mathworks.com/help/physmod/sps/ref/pmsmfieldorientedcontrol.html
4) Electric Vehicle Conductive AC Charging System
https://dhi.nic.in/writereaddata/UploadFile/REPORT%20OF%20COMMITTEE636469551875975520.pdf
Electric Vehicle Conductive AC Charging System

vi) 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	8
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.	9

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- Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC).	**10**
IV	**Energy Storage**: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System,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 EVSE to On-board chargers to battery pack power flow block schematic diagrams. **Types of charging stations** - AC Level 1 & 2, DC - Level 3 –V2G concept-Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences	**11**
V	**Vehicle Communication protocols**: Need & requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV	**7**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44E	SOLAR PV SYSTEMS	PEC	2	1	0	3	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: 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.

iii) 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 and outline the advanced PV technologies.	Apply
CO5	Demonstrate the overcurrent protection methods and economics of PV Systems.	Understand

iv) 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. 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.

v) (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) 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) A. Duffie and W.A. Beckman, *Solar Energy Thermal Processes*, J. Wiley, 1994.
3) Thomas E. Kissell, David M. Buchla, Thomas L. Floyd, *Renewable Energy Systems*, Pearson, 2017.
4) G. N. Tiwari, Arvind Tiwari, Shyam, *Handbook of Solar Energy: Theory, Analysis and Applications*, Springer, 2016.
5) F. Kreith and J.F. Kreider, *Principles of Solar Engineering*, McGraw Hill, 1978.
6) Khan B. H., *Non-Conventional Energy Resources*, Tata McGraw Hill, 2009.
7) D.P. Kothari, K.C. Singal, Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2009.
8) Rao S. and B. B. Parulekar, *Energy Technology*, Khanna Publishers, 1999.
9) Sab S. L., *Renewable and Novel Energy Sources*, MI. Publications, 1995.
10) Sawhney G. S., *Non-Conventional Energy Resources*, PHI Learning, 2012.
11) Abbasi S. A. and N. Abbasi, *Renewable Energy Sources and their Environmental Impact*, Prentice Hall of India, 2001.
12) Boyle G. (ed.), *Renewable Energy: Power for Sustainable Future*, Oxford University Press, 1996.
13) Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, *Renewable Energy – Sources for Fuel and Electricity*, Earth scan Publications, London, 1993.
14) Tara Chandra Kandpal, Hari Prakash Garg, *Financial evaluation of Renewable Energy Technologies*, Mac Millam India Limited, 2003.
15) 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.1-217, 15 April 2009, doi: 10.1109/IEEESTD.2008.4816078.

vi) 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.	**9**
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) – performance evaluation. Applications - Solar Cooking Systems- Principle of cooking- cooking	**9**

	by boiling- 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).	
III	Solar PV Systems-Introduction - Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect - Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell -Generation of Solar Cell (Photovoltaic) Materials-.Photovoltaic (PV) Module and PV Array – Single - Crystal Solar Cell Module, Thin-Film PV Modules, III – V Single Junction and Multifunction 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.	**9**
IV	Solar PV Systems – 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.	**9**
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**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44Z	HVDC AND FACTS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Power Electronics & Power Systems

ii) COURSE OVERVIEW: The course deals with the importance of HVDC transmission, analysis of HVDC Converters, Harmonics and Filters, Reactive power control and Power factor improvements of the system. It also deals with basic FACTS concepts, static shunt and series compensation and combined compensation techniques.

iii) COURSE OUTCOMES

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

CO1	Compare AC and DC systems, Explain the types of HVDC Links, various parameters in HVDC and FACTS devices.	Understand
CO2	Analyze the Graetz circuit with various conditions.	Analyze
CO3	Explain various control schemes, harmonics and design the Filters in HVDC.	Understand
CO4	Summarize the Operation of various Shunt devices and their control.	Understand
CO5	Explain the Operation of various Series devices and their control.	Understand

iv) SYLLABUS

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

ANALYSIS OF HVDC CONVERTERS Analysis of Graetz circuit Analysis of HVDC converters, 12 Pulse converters-relations between AC and DC quantities.

HVDC SYSTEM CONTROL, HARMONICS Basic control-desired features of control-actual control Characteristics-Generation of harmonics (Characteristics and Non-characteristics harmonics), Design of DC and AC filters

STATIC SHUNT COMPENSATION Objectives of Shunt Compensation, Power Oscillation Damping, Methods of controllable VAR generation – Variable Impedance type only.

STATIC SERIES COMPENSATORS: Concept of series capacitive compensation, Improvement of Transient Stability, Power Oscillation Damping, Sub Synchronous Oscillation Damping-control schemes for GCSC, TSSC and TCSC.

v) (a) TEXT BOOKS

1) K. R.Padiyar, *HVDC Transmission Systems*, 2nd edition (in Two Colour), New Age International publishers, 2012.
2) N. G. Hingoraniand 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, New York, 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.

vi) 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** Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, Benefits from FACTS controllers.	**9**
II	**Analysis of HVDC converters** Introduction, Analysis of Graetz circuit –with grid control but no overlap-with grid control and overlap less than 600 - 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, 12 Pulse converters-relations between AC and DC quantities.	**9**
III	**HVDC system control, harmonics and filters**: 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- IPC-EPC. Introduction, Generation of harmonics (Characteristics and Non-characteristics harmonics), Design of DC and AC filters (design and types of filters)	**9**

IV	**Static Shunt Compensation:** Objectives of Shunt Compensation, midpoint voltage regulation voltage Instability prevention, Improvement of Transient Stability, Power Oscillation Damping, Methods of controllable VAR generation – Variable Impedance type only.	**9**
V	**Static Series Compensators:** Concept of series capacitive compensation, Improvement of Transient Stability, Power Oscillation Damping, Sub Synchronous Oscillation Damping. Functional requirements of GTO Thyristor Controlled Series Capacitor (GCSC), control schemes of Thyristor Switched Series Capacitor (TSSC), and Thyristor Controlled Series Capacitor (TCSC) control schemes for GCSC, TSSC and TCSC.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44Y	MODERN CONTROL TECHNIQUES	PEC	2	1	0	3	2022

i) PRE-REQUISITE:

EE1U30I: Introduction to Control Engineering

ii) COURSE OVERVIEW:

This course provides a comprehensive understanding of modern approaches in control system analysis and design. It covers state-space modeling, controllability, observability, digital control techniques, and nonlinear system behavior. Emphasis is placed on practical tools and methods such as pole placement, observer design, Lyapunov stability, and Z-transform-based analysis. The course also introduces adaptive and intelligent control strategies including Model Predictive Control, Neural Networks, and Fuzzy Logic, enabling students to address contemporary control challenges in industrial and research settings.

iii) COURSE OUTCOMES

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

CO1	Explain the concept of state variables and formulate state-space models of physical systems.	Understand
CO2	Apply controllability and observability tests to determine the feasibility of control and estimation in dynamic systems.	Apply
CO3	Apply Z-transform techniques to analyze and design discrete-time control systems.	Apply
CO4	Explain the dynamic behavior of nonlinear systems and the significance of phase-plane and Lyapunov methods in stability analysis.	Understand
CO5	Summarize modern control strategies such as Model Predictive Control, Neural Networks, and Fuzzy Logic Controllers and their potential applications.	Understand

iv) SYLLABUS

State-space representation of dynamic systems – Solution of state equations – Controllability and observability – State feedback and observer design.

Basics of digital control systems – Z-transform and stability analysis in Z-domain – Phase-plane analysis – Lyapunov's stability method.

Introduction to describing function – Fundamentals of adaptive control – Overview of intelligent control techniques including Model Predictive Control, Neural Networks, and Fuzzy Logic Controllers.

v) (a) TEXT BOOKS

1) Katsuhiko Ogata, *Modern Control Engineering*, 5th Edition, Pearson Education, 2010.

2) M. Gopal, *Digital Control and State Variable Methods*, 4th Edition, McGraw Hill Education, 2012.
3) Benjamin C. Kuo and Farid Golnaraghi, *Automatic Control Systems*, 9th Edition, Wiley, 2014.

(b) REFERENCES

1) Gene F. Franklin, J. David Powell, and Michael L. Workman, *Digital Control of Dynamic Systems*, 3rd Edition, Pearson, 1997.
2) M. Gopal, *Modern Control System Theory*, 2nd Edition, New Age International, 2005.
3) Karl J. Åström and Björn Wittenmark, *Adaptive Control*, 2nd Edition, Dover Publications, 2013.
4) Mohammed S. Mahmoud, *Fuzzy Logic Control: Advances in Applications*, CRC Press, 2018.
5) Brian Roffel and Ben Betlem, *Advanced Practical Process Control*, Springer, 2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**State-Space Modeling and Analysis** Concept of state, state variables, and state-space representation – Derivation of state-space models from physical systems – Solution of state equations using transition matrix – Canonical forms.	9
II	**Control Design in State-Space** Controllability and observability tests (Kalman criteria) – State feedback design using pole placement – Observer design: Full-order observer – Introduction to Kalman Filter (conceptual only).	9
III	**Digital Control Systems** Discretization of continuous systems: zero-order hold – Z-transform and inverse Z-transform – Pulse transfer function – Stability analysis in Z-domain using Jury's test.	9
IV	**Nonlinear Systems and Stability** Common physical nonlinearities: saturation, dead zone, backlash – Phase-plane analysis – Stability using Lyapunov's direct method – Introduction to describing function method.	9
V	**Adaptive and Intelligent Control** Model Reference Adaptive Systems (MRAS) – Basics of Model Predictive Control (MPC) – Overview of Artificial Neural Networks and Fuzzy Logic Controllers – Concept of Reinforcement Learning in control.	9
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44X	HIGH VOLTAGE ENGINEERING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EE1U30A: Power Systems I

ii) COURSE OVERVIEW:

This course gives insights into the generation of different type of high voltage waveforms, their measurement and analysis including the insulation coordination of different equipment and machinery used in high voltage applications. It also provides a basic idea of FACTS devices and testing with the help of different testing circuits.

iii) COURSE OUTCOMES

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

CO1	Outline different high voltage and current waveform generation circuits.	Understand
CO2	Explain different sensing & measurement techniques for high voltage and current measurement.	Understand
CO3	Explain the terms related to insulation coordination and surge arrestors.	Understand
CO4	Outline different FACTS devices and their application in HV systems.	Understand
CO5	Illustrate different testing methods for equipments and applications of HV systems.	Understand

iv) SYLLABUS

Generation of High DC and AC Voltages - Generation of impulse voltages – High voltage and high current measurements.

High voltage testing - Measurement of dielectric constant and loss factor- Partial discharge measurements.

Insulation Coordination and surge arresters - Classification of Voltages and Over voltages - Insulation Coordination Procedure.

HVDC and FACTS - HVDC transmission - - Static var compensators (SVCs), STATCOM, Series compensators, Unified power flow controller (UPFC).

Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers, surge diverters, cables - Insulation Systems for AC Voltages - Lightning Protection.

v) (a) TEXT BOOKS

1) C.L Wadhwa, *High voltage Engineering*, New age international (P) Ltd, 3rd edition, 2012.
2) Naidu M.S. and Kamaraju V., *High voltage Engineering*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
3) Andreas Kuchler, *High Voltage Engineering Fundamentals – Technology – Applications*, Springer, 2018.

4) N.G. Hingorani and L.Gyugyi, *Understanding FACTS*, IEEE Press, 2000.

(b) REFERENCES

1) Farouk A.M. Rizk & Giao N. Trinh, *High Voltage Engineering*, CRC Press, 2014.
2) Kuffel, E., Zaengl, W.S. and Kuffel J., *High Voltage Engineering Fundamentals*, Elsvier India P Ltd, 2005.
3) Hugh M. Ryan, *High-Voltage Engineering and Testing*, IET Power and energy series, 2013.
4) Dieter Kind, Kurt Feser, *High voltage test techniques*, Elsevier Science, 2nd edition, 2001.
5) Khalil Denno, *High Voltage Engineering in Power Systems*, CRC Press, Newyork, 1992.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Generation of High Voltage and Currents.** Generation of High DC and AC Voltages- half-wave rectifier circuit – Cockroft - Walton voltage multiplier circuit - Electrostatic generator - Generation of high AC voltages - Cascaded Transformers- Series resonant circuit. Generation of Impulse Voltages and Currents - Impulse voltage- Impulse generator circuits - Multistage impulse generator circuit - Construction of impulse generator - Triggering of impulse generator -Impulse current generation.	9
II	**HV measuring techniques** High Voltage Measurement Techniques -Measuring Spark Gaps - Sphere-to-sphere Spark Gap - Rod-to-rod Spark Gap - Electrostatic Voltmeter- Electro-optical and Magneto-optical Field Sensors - Voltage Dividers - Instrument Transformers - Measurements of R.M.S. Value, Peak Value and Harmonics - Current Measurement. Dielectric measurements - Dissipation Factor and Capacitance, Insulation Resistance, Conductivity, Dielectric System Response.	10
III	**Insulation Coordination and surge arresters** Insulation Coordination Procedure- Determination of Representative Voltages and Overvoltages - Continuous Power Frequency Voltage, Temporary Overvoltages, Slow-Front Overvoltages, Fast-Front Overvoltages. Determination of Coordination Withstand Voltage- Deterministic Approach, Statistical Approach: Risk of Failure. Surge Arresters- Rated Voltage- Discharge Current - Impulse Current Tests- Residual Voltages.	10
IV	**FACTS**: Series and Shunt compensation- Static Shunt compensators: Static var compensators (SVCs), STATCOM, Statis Series compensators: TSSC, TCSC, SSSC. Unified power flow controller (UPFC). Static Voltage and phase angle regulators: TCVR and TCPAR.	8

V	**Testing of HV Systems:** High voltage testing of insulators, bushings, isolators, circuit breakers, transformers, surge diverters, cables. Insulation Systems for AC Voltages -Cables, bushings and transformers- Insulation Systems for DC Voltages- Capacitors, HVDC bushings and Cables-Insulation Systems for Impulse Voltages -Electrical Stress and Strength -Energy Storage -Impulse Capacitors (Energy Storage or Surge Capacitors).	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44G	BIG DATA ANALYTICS	PEC	3	0	0	3	2022

i) PREREQUISITE: Nil

ii) COURSE OVERVIEW: This course introduces the fundamental algorithmic ideas and tools for processing and analyzing big data. Key topics include the Hadoop ecosystem, MapReduce programming, and basic analytics using R. It emphasizes practical applications and the interpretation of machine learning models.

iii) COURSE OUTCOMES

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

CO1	Explain the key concepts of data science.	Understand
CO2	Explain big data and use cases from selected business domains	Understand
CO3	Apply Hadoop and related tools like Pig and Hive to perform big data analytics	Apply
CO4	Make use of Python language to perform preliminary data analytics.	Apply
CO5	Apply machine learning approaches to process and interpret data.	Apply

iv) SYLLABUS

Data science in a big data world, Facets of data, Data science process, Retrieving data, Data Exploration-Data modelling. Big Data Overview - The five V's data, State of the Practice in Analytics, Apache Hadoop and the Hadoop Ecosystem, HDFS Concepts, Managing File system Metadata, Map Reduce. Analysing the Data with Hadoop using Map and Reduce-Developing a Map Reduce Application, Scheduling, Task execution, Big data Management Tools: PIG, HIVE, Introduction to NoSQL. Review of Basic Analytic methods using Python - Introduction to Python, Descriptive Statistics, Exploratory Data Analysis, statistical models in Python, Graphical Procedures. Machine learning - Introduction to Machine Learning, Supervised Learning - Regression, Classification, Unsupervised Learning, Model Selection and validation, Measuring classifier performance.

v) (a) TEXT BOOKS

1) Davy Cielen, Arno D. B. Meysman, and Mohamed Ali, *Introducing Data Science - Big data, machine learning, and more, using Python tools*, Dreamtech Press, 2016.
2) Tom White, *Hadoop: The Definitive Guide*, 3rd Edition, O'Reilley, 2012.
3) Matloff, Norman, *The art of R programming: A tour of statistical software design*, No Starch Press, 2011.

(b) REFERENCES

1) Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, *Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*, Wiley, 2013.

2) EMC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, Wiley, January 2015.
3) Eric Sammer, *Hadoop Operations*, O'Reilly Media, Inc, 2012.
4) E. Capriolo, D. Wampler, and J. Rutherglen, *Programming Hive*, O' Reilley, 2012.
5) Alan Gates, *Programming Pig*, O'Reilley, 2011.
6) Ethem Alpaydın, *Introduction to Machine Learning (Adaptive Computation and Machine Learning*), MIT Press, 2004.
7) Shai Shalev-Shwartz, Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014.
8) Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.
9) Crawley, Michael J., *The R book*, John Wiley & Sons, 2012.
10) Sourabh Mukherjee, Amit Kumar Das and Sayan Goswami, *Big Data Simplified*, Pearson, 1st Edition, 2019.
11) Murtaza Haider, "*Getting Started with Data Science*", 1st Edition, Kindle Edition, IBM Press, 2015.
12) Thomas Erl, Wajid Khattak and Paul Buhler "*Big Data Fundamentals: Concepts, Drivers and Techniques*", Prentice Hall, Pearson Service, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Data Science and Big Data - Data Science Overview**: Benefits, uses, and facets of data science. **Big Data Ecosystem**: The data science process, roles, and project stages. **Data Handling**: Defining research goals, retrieving data, cleaning, integrating, and transforming data. **Data Exploration and Modelling**: Techniques for data visualization, modelling, presentation, and automation.	9
II	**Big Data Foundations and Hadoop Ecosystem - Big Data Fundamentals:** Five Vs of big data, analytics landscape, and use cases. **Hadoop Overview:** Architecture, HDFS concepts, reading/writing data, and metadata management. **MapReduce:** Core stages, design principles, daemons, and YARN.	9
III	**Data Analytics with Hadoop Tools - MapReduce Programming:** Developing applications, job anatomy, scheduling, shuffle/sort, and task execution. **Big Data Tools: Pig:** Overview, execution modes, Pig Latin basics. **Hive:** Architecture, HiveQL basics. **NoSQL**: Introduction to NoSQL databases and applications.	9
IV	**Basic Analytics with Python – Introduction to Python:** Data import/export, data types, factors, arrays, matrices, lists, and data frames. **Data Analysis:** Descriptive statistics, exploratory data analysis (EDA), handling dirty data, and visualizations.	9

V	**Machine Learning Basics - Overview**: Examples of ML applications and core concepts. **Supervised Learning:** Regression: Single and multivariable models. Classification: Logistic regression basics. Unsupervised Learning: Clustering with K-means. **Reinforcement Learning:** Introduction and practical relevance. **Model Validation:** k-fold cross-validation, precision, recall, and classifier performance metrics.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1U44W	DIGITAL IMAGE PROCESSING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course aims to provide a strong foundation on image processing. It helps to study image fundamentals, mathematical transforms needed in image processing, image restoration, enhancement and image compression procedures. Fundamentals of morphological image processing will be discussed.

iii) 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	Make use of matrix theory and mathematical transforms for image processing.	Apply
CO3	Apply various image enhancement techniques in spatial and frequency domain.	Apply
CO4	Interpret various image segmentation techniques.	Understand
CO5	Explain the techniques for compression and restoration of images.	Understand

iv) 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 Enhancement in Spatial domain: Basic Gret level transforms, Histogram, Histogram processing: Smoothening and sharpening filters, Laplacian Filters. Image Enhancement in Frequency domain. Image segmentation: Segmentation and threshold function, Matching, Colour segmentation. Image compression: Need for image compression, Basics of image compression standards- JPEG, MPEG. Image restoration-Blind image Restoration. Familiarization of Image Processing with MATLAB.

v) (a) TEXT BOOKS

1) Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Fourth Edition, Pearson Education,2018
2) S Jayaraman, S Esakkirajan, T Veerakumar, *Digital Image Processing* ,5th edition, Tata Mc Graw Hill, 2015.
3) Malay K. Pakhira, *Digital Image Processing and Pattern Recognition*, 1st edition, PHI Learning Pvt. Ltd., 2011.

(b) REFERENCES

1) Anil.K. Jain, *Fundamentals of Digital Image Processing*, PHI, First Edition - 1 January 2015 ISBN-13: 978-9332551916.
2) William K. Pratt, *Digital Image Processing*, John Wiley & Sons, 2006; Print ISBN:9780471767770.
3) Chanda Dutta Magundar, *Digital Image Processing and Applications*, PHI, 2nd edition, 2000.
4) Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, CL Engineering, 2007.

vi) 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. 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 - Toeplitz, Circulant and Block matrix. Basic geometric transformations-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 Enhancement in Spatial domain: Basic Gray 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**
IV	Image segmentation: Segmentation and threshold function, Algorithms in thresholding, line detection, edge detection, edge linking by Graph Search Method, Hough Transform, Region based segmentation, Matching, Colour segmentation.	**8**
V	Image compression: Need for image compression, Lossless compression: Variable length coding – LZW coding – Bitplane coding, predictive coding-DPCM. Lossy Compression: Transform coding – Wavelet coding – Basics of Image compression standards: JPEG, MPEG. Model of Image Degradation/restoration process – Noise models Inverse filtering –Least mean square filtering – Constrained least mean square filtering – Blind image restoration – Pseudo inverse – Singular value decomposition, Familiarization of Image Processing with MATLAB.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 arks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

MINORS/HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0M49A/ EE0M49B	MINI PROJECT	VAC	0	1	6	4	2022

i) PREAMBLE:

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The objective of Project Work is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on 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. Each project assignment should typically include the following components:

- Survey and study of relevant published literature on the assigned topic
- Preparation of an action plan for conducting the investigation, including team roles and responsibilities
- Development of a preliminary approach to the problem related to the assigned topic
- Documentation of block-level design
- Conducting preliminary analysis, modeling, simulation, experimentation, design, or feasibility study
- Preparation of a written report on the study conducted, for presentation to the department

ii) COURSE OUTCOMES

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

CO1	Identify engineering problems and formulate appropriate solutions.	Apply
CO2	Plan project activities and coordinate effectively within a team to meet deadlines.	Apply
CO3	Evaluate proposed solutions through theoretical analysis and experimental validation.	Evaluate
CO4	Develop technical reports and demonstrate effective communication skills.	Create
CO5	Present technical content clearly and justify ideas with logical reasoning.	Evaluate

iii) COURSE PLAN

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with Faculty-in-charge of mini project /Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives.

Demonstrate the novelty of the project through the 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. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

iv) CONTINUOUS ASSESSMENT EVALUATION PATTERN

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, 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. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

v) CONTINUOUS INTERNAL EVALUATION (CIE) PATTERN

Attendance	:	10 marks
Marks awarded by Guide	:	15 marks
Project Report	:	10 marks
Evaluation by the Committee	:	40 marks
Total	:	**75 marks**

vi) END SEMESTER EXAMINATION (ESE) PATTERN

Level of completion	:	10 marks
Demonstration of functionality	:	25 marks
Project Report	:	10 marks
Viva-voce	:	20 marks
Presentation	:	10 marks
Total	:	**75 marks**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE
150	75	75

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1H49A	MINI PROJECT	VAC	0	1	6	4	2022

i) PREAMBLE:

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The objective of Project Work is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on 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. Each project assignment should typically include the following components:

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Demonstration of functionality	:	25 marks
Project Report	:	10 marks
Viva-voce	:	20 marks
Presentation	:	10 marks
Total	:	**75 marks**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE
150	75	75