KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

UDYAMBAG, BELAGAVI-590008

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)

(APPROVED BY AICTE, NEW DELHI)

Department of Electrical & Electronics Engineering

B.E. (Electrical & Electronics Engineering)

Scheme and Syllabus (2021 Scheme)

5th to 8th Semester

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION

To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem solving ability with an analytical and innovative mindset.

QUALITY POLICY

- Imparting value added technical education with state-of-the-art technology in a congenial, disciplined and a research oriented environment.
- Fostering cultural, ethical, moral and social values in the human resources of the institution.
- Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

DEPARTMENT VISION
Department of Electrical and Electronics Engineering focuses on Training Individual aspirants for Excellent Technical aptitude, performance with outstanding executive caliber and industrial compatibility.

MISSION
To impart optimally good quality education in academics and real time work domain to the students to acquire proficiency in the field of Electrical and Electronics Engineering and to develop individuals with a blend of managerial skills, positive attitude, discipline, adequate industrial compatibility and noble human values.

PROGRAM OUTCOMES (POs)	
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, 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.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

1. Apply the concepts of Electrical and Electronics Engineering necessary to attend engineering problems in multidisciplinary domain with a blend of social and environmental aspects with technical and professional competence

2. Participate in the activities that lead to professional and personal growth with self-confidence to adapt to ongoing changes in technology and career development.

3. Develop managerial and entrepreneurship skills embedded with human and ethical values.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1.To demonstrate an understanding of the basic concepts Electrical and Electronics technology with an adequate knowledge of mathematics and science during problem analysis, formulation of solutions, design and development activities.

2. To demonstrate an understanding of the concepts of the core Electrical Engineering aspects such as Electrical machines and Power systems during real time analysis, design and operation.

3.To demonstrate an understanding of the concepts of Electronics technology in the form of Analog and Digital Electronics, Microprocessors and embedded systems required in data acquisition, data processing, automation and control applications and demonstrate capability to comprehend the technological advancements and usage of modern tools keeping up lifelong learning attitude.

4. To demonstrate good managerial and entrepreneurship skills embedded with good communication skill, team work attitude professional ethics and the concern for societal and environmental goodness.

KLS Gogte Institute of Technology

B.E. in (ELECTRICAL & ELECTRONICS ENGINEERING)

Scheme of Teaching and Examination 2021-22 as per NEP 2020

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2021-22)

Total credits for B.E. Program: 160

As per the guidelines of UGC CBCS the courses can be classified into:

Abbreviations used:

BSC - Basic Science Course, **PCC-** Professional Core Course, **HSMC -** Humanity and Social Science & Management Courses, PEC- Professional Elective Course, **OEC –** Open Elective Course, **AEC –** Ability Enhancement Courses. **INT –** Internships, **UHV –**Universal Human Values, **MP -** Mini Project.

L –Lecture, **T –** Tutorial, **P-** Practical/Drawing, **S –** Self Study Component, **CIE –**Continuous Internal Evaluation, **SEE –**Semester End Examination

Foundation Courses: The Foundation Courses are of two kinds:

These courses are the courses based upon the content that leads to Knowledge enhancement. These courses provide opportunities to improve technological knowledge before entering industry as well as preparing students for higher degrees in technological subjects. They are mandatory for all disciplines. These courses will have 4 credits per course.

The courses are: **Basic Science Courses (BSC), Engineering Science Courses (ESC)**.

Professional Core Courses (PCC): This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirements of a program in a said discipline of study. These courses will have 4 credits per course.

Universal Human Value Courses (UHV): These are value based courses aimed at man making education.

Humanities and Social Science including Management Studies Courses(HSMS).Humanity and Social Science Courses: The Humanities and Social Sciences are the studies of human behavior and interaction in social,

cultural, environmental, economic, and political contexts. The Humanities and Social Sciences have a historical and contemporary focus, from personal to global contexts, and consider challenges for the future. Students will develop the ability to question, think critically, solve problems, communicate effectively, make decisions, and adapt to change. Thinking about and responding to issues requires an understanding of the key historical, geographical, political, economic, and societal factors involved, and how these different factors interrelate. Humanities and Social Science Courses includes-Technical-English, Courses on Regional/State languages (Kannada), etc.

Elective Courses: This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills. These courses will have 3 credits per course.

An elective may be **Discipline Centric Course (PEC)** or may be chosen from other discipline (**Open Elective Course- OEC**).

Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

"AECC" courses are the courses based upon the content that leads to Knowledge enhancement; Environmental Science, English. Biology for Engineers, Bioinformatics, Music and Vibration, Art and Architecture etc

"SEC" courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Mandatory Non-Credit Courses (MNC): These courses are mandatory but do not have any credits and students must successfully complete these courses before the completion of degree.

Theory courses having the corresponding lab are converted to integrated type course. Also, the electives (if possible) can also be made integrated type.

Integrated courses (Professional Core/Electives): Integrated courses will have **Theory Syllabus with Practical Syllabus of the same course**. In such a course there could be **no Semester End Examination (SEE) for the practical syllabus**of the course, however, Continuous Internal Evaluation (CIE) will be conducted for the practical topics.

Credit definition:

Offline Courses	Online Courses
• 1-hour Lecture **(L)** per week = 1 Credit • 2 hours Tutorial**(T)** per week = 1 Credit, • 2 hours Practical /Drawing **(P)** per week = 1 Credit	04 weeks =1 Credit 08 weeks = 2 Credit 12 weeks = 3 Credit
• Four-credit courses are to be designed for 50 hours of Teaching-Learning process. • Three credit courses are to be designed for 40 hours of Teaching-Learning process. • Two credit courses are to be designed for 25 hours of Teaching-Learning process. • One credit courses are to be designed for 15 hours of Teaching-Learning process.	

Semester wise distribution of credits for B.E program

Year	Semester	Credits	Total/Year	Cumulative Credits
1st	AE, CV, ME (I-P& II-C)	19+21	40	40
	CSE, EC, EE, ISE (I-C &II-P)	18+22		
2nd	III	20	40	80
	IV	20		
3rd	V	23	45	125
	VI	22		
4th	VII	17	35	160
	VIII	18		
Total			160	

Curriculum frame work:

Structure of Undergraduate Engineering program

S.No.	Category of courses	VTU Breakup of credits	KLSGIT Breakup of credits
1	Humanities and Social Sciences including Management courses (English, Kannada, Indian Constitution, Environmental Sciences and Management)	10	8
2	Basic Science courses	23	22
3	Engineering Science courses including workshop, drawing	20	20
4	Professional Core Courses	46	49
5	Professional Elective courses relevant to chosen specialization/branch	9	9
6	Open subjects – Electives from other technical, emerging, arts commerce and	6	9
7	Mini, Project, Major Project work and Seminar	13	9
8	Summer Internship and Research /Industrial Internship	20	20
9	Ability Enhancement Courses, including Research Methodology, NCC/NSS/ Sports/Ex- Curricular, Online Certification Course	11	12
10	Universal Human Values	2	2
	TOTAL	**160**	**160**

L-T-P Model for Courses

	Contact Hours				Credits	
S.No.	**L-T-P**	**Lecture**	**Tutorial**	**Practical**	**L-T-P**	**Total**
1	3 - 0 - 0	3	0	0	3 - 0 - 0	3
2	3 - 2 - 0	3	2	0	3 - 1 - 0	4
3	3 - 0 - 2	3	0	2	3 - 0 - 1	4
4	2 - 0 - 2	2	0	2	2 - 0 - 1	3
	1 - 0 - 4	1	0	4	1 - 0 - 2	3

Theory courses having the corresponding lab are converted to integrated type course. Also, the electives (if possible) can also be made integrated type.

Integrated courses (Professional Core/Electives): Integrated courses will have **Theory Syllabus with Practical Syllabus of the same course**. In such a course there could be **no Semester End Examination (SEE) for the practical syllabus** of the course, however, Continuous Internal Evaluation (CIE) will be conducted for the practical topics.

5th Semester					Hours/week				Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P	S			CIE	SEE	Total
1	PCC	21EE51	Power System Analysis and Stability	EE	3	0	0		3	3	100	100	200
2	PCC	21EE52	Internet of Things and Data Acquisition	EE	3	0	2		5	4	100	100	200
3	PCC	21EE53	Linear Integrated Circuits	EE	3	0	2		5	4	100	100	200
4	PEC	21EEPE54X	Professional Elective-1	EE	3	0	0		3	3	100	100	200
5	OEC	21EEOE55X	Open Elective -1	EE	3	0	0		3	3	100	100	200
6	INT	21EE56	**Summer Internship - II**		0	0	6		6	3	100	-	100
7	AEC	21AECEE57	Research Methodology & Intellectual property rights		1	0	0		1	1	50	50	100
8	AEC	21AECEE58	Employability Skills -1		1	0	0		1	1	100	-	100
9	HSMS	21EE59A	Environmental Studies	Chem/CV	1	0	0		1	1	50	50	100
10	HSMS	21EE59B*	Communicative English*	English	2	0	0		2	MNC	50	-	50
			TOTAL							**23**	850	600	1450

Environmental Studies: Paper setting: Civil Engineering Board

***Only for Lateral Entry Diploma students**

Summer Internship-II: At the End Of fourth Semester four - weeks Summer Internship Shall Be Carried Out – Based on Industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. Credited In fifth Semester. All the students admitted shall have to undergo mandatory internship of 04 weeks during the vacation of IV semesters. A Viva-Voce examination shall be conducted during V semester and the prescribed credit shall be included in V semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

PROFESSIONAL ELECTIVES	
Code	**PE 1**
21EEPE541	Fuzzy logic
21EEPE542	PLC & Industrial Automation
21EEPE543	Network Analysis
21EEPE544	OOP with C++
21EEPE545	Electrical Measurements & Instrumentation

OPEN ELECTIVES	
Code	**OE 1**
21EEOE551	Renewable Energy Sources
21EEOE552	Special Electrical Machines
21EEOE553	Industrial Motors
21PH551	Introduction to Astronomy (Physics Dept)
21INT52	PLC & SCADA (in association with Industry)

Professional Elective: The minimum students' strength for offering professional electives is **05**, if the strength is less than the 05 then the department has to take the permission to offer the course.

Open Elective Courses: All Open Electives are offered to students of all branches in general. However, a student shall choose an open Elective from the list in such a manner that he/she has not studied the same course in any form during the Programme. Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department.

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.
- Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Courses from Law, Business (MBA), Medicine, Arts, Commerce, may be offered as Open Elective Courses (OEC).

The minimum students' strength for offering professional electives is **05,** if the strength is less than the 05 then departments have to take the permission to offer the course.

6th Semester					Hours/week				Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P	S			CIE	SEE	Total
1	HSMS	21EE61	Industrial Management, Electrical Estimation & Costing	EE	3	0	0		3	3	100	100	200
2	PCC	21EE62	Control Systems	EE	3	0	0		3	3	100	100	200
3	PCC	21EE63	Computer Techniques in Power System Analysis	EE	3	0	2		5	4	100	100	200
4	PCC	21EE64	Power System Protection & High Voltage Engineering	EE	3	0	2		5	4	100	100	200
5	PEC	21EEPE65X	Professional Elective-2	EE	3	0	0		3	3	100	100	200
6	OEC	21EEOE66X	Open Elective -2		3	0	0		3	3	100	100	200
7	MP	21EE67	Mini Project		0	0	2		2	1	100	-	100
8	AEC	21AECEE68	Employability Skills -2		1	0	0		1	1	100	-	100
			TOTAL							**22**	800	600	1400

PROFESSIONAL ELECTIVES	
Code	**PE 2**
21EEPE651	Field Theory
21EEPE652	Advanced Power Electronics
21EEPE653	Signals, Systems & Processing
21EEPE654	Electric Vehicles
21EEPE655	Testing & Commissioning of Electrical Equipments

OPEN ELECTIVES	
Code	**OE 2**
21EEOE661	Optimization Techniques
21EEOE662	Fuzzy Logic
21EEOE663	Electric Vehicles
21CH661	Nanoscience and Nanotechnology (Chemistry Dept)
21INT61	Robotics & Automation (in association with Industry)

Mini-project work(Single discipline/Interdisciplinary): Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or a group having not more than 4 students. (or Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications)

Research/Industrial Internship - At the End of the sixth / Seventh semester (in two cycles to accommodate all the students of the University) Research/Industrial Internship shall be carried out – Based on industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. All the students admitted shall have to undergo a mandatory internship of 24 weeks during the vacation of VI/VII semesters. A Viva-Voce examination shall be conducted during VII/VIII semester and the prescribed credit shall be included in VII/VIII semester. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

Research internship: Students have to take up research internships at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organizations / Institutes. A research internship is intended to give you the flavour of current research going on a particular topic/s. The internships serve this purpose. They help students get familiarized with the field, the skill needed the effort amount and kind of effort required for carrying out research in that field.

7th Semester					Hours/week				Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P	S			CIE	SEE	Total
1	PCC	21EE71	Electric Drives & Traction	EE	3	0	0		3	3	100	100	200
2	PEC	21EEPE72X	Professional Elective-3	EE	3	0	0		3	3	100	100	200
3	OEC	21EEOE73X	Open Elective - 3	EE	3	0	0		3	3	100	100	200
4	Project	21EE74	Project work		0	0	14		14	7	100	100	200
5	AEC	21AECEE75	Sports/Cultural/NSS/NCC/Club activities					1	1	1	100	-	100
			TOTAL							**17**	500	400	900

PROFESSIONAL ELECTIVES	
Code	**PE 3**
21EEPE721	Embedded Systems
21EEPE722	HVDC & FACTS
21EEPE723	Smart Grids
21EEPE724	Modern Control Theory
21EEPE725	Renewable Energy Sources

OPEN ELECTIVES	
Code	**OE 3**
21EEOE731	Electrical Energy Conservation & Auditing
21EEOE732	Solar & Wind Energy
21EEOE733	Energy Storage Systems
21INT71	Internet of Things & Artificial Intelligence (in association with industry)

8th Semester					Hours/week				Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P	S			CIE	SEE	Total
1	Seminar	21EE81	Technical Seminar		0	0	1		1	1	100	-	100
2	AEC	21EE82	Certification (Minimum 6 - 8 weeks)		0	0	4		4	2	100	-	100
3	Internship	21EE83	Research/Industry Internship (24 weeks)		0	0	30		30	15	100	100	200
			TOTAL							**18**	300	100	400

Certification (Shall have proctored examination):

- NPTEL/SWAYAM/NASSCOM /Industry-Institute partnered certification.
- List of the courses will be notified by the departments

Internship

4 weeks internship can be completed after 6thsem, 4 weeks internship can be completed after 7thsem and 16 weeks internship can be completed in 8th sem.

TECHNICAL SEMINAR: The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization& perform the following activities.

(i) Carry out literature survey, systematically organize the content.
(ii) Prepare the report in their own words, avoiding a cut and paste technique.
(iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such tools.
(iv) Present the seminar topic orally and/or through PowerPoint slides.

(v) Answer the queries and involve in debate/discussion.

(vi) Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure: The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department.

The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

- Seminar Report:50 marks Presentation skill:25 marks
- Question and Answer: 25 marks.
- No SEE component for Technical Seminar

POWER SYSTEM ANALYSIS & STABILITY

Course Code	21EE51	Course type	PCC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Model and represent power systems.
2.	Understand and explain the various types of faults and transients in power systems and rating of circuit breakers.
3.	Understand, explain and analyze the symmetrical and unsymmetrical faults, to explain sequence impedances and networks of power system elements.
4.	Analyze power system stability and its implications.

Pre-requisites : Electrical machines, Power transmission & distribution

Unit – I: Representation of power system components	Contact Hours = 8 Hours
Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams, Per unit system, per unit impedance diagram of power system.	

Unit – II : Symmetrical faults	Contact Hours = 8 Hours
Transients in an R-L circuit, synchronous machine reactances, short circuit current, analysis of loaded generators, symmetrical faults on power systems, short circuit MVA, rating and selection of circuit breaker.	

Unit – III: Symmetrical components	Contact Hours = 8 Hours
Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances and Sequence Networks of Synchronous Machines, Transmission Lines and Transformers, Construction of Sequence Networks of a Power System.	

Unit – IV: Unsymmetrical faults:	Contact Hours = 8 Hours
Content of the Unit: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults	

Unit –V: Power System Stability	Contact Hours = 8 Hours
Content of the Unit: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability, Multi-machine stability studies, classical representation.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	W.D.Stevenson, **"Elements of Power System Analysis",** TMH,4th edition.
2.	I. J. Nagrath and D.P.Kothari, **"Modern Power System Analysis",** TMH, 3rd Edition, 2003.
3.	K.Uma Rao, **"Computer Techniques and models in power systems",** I.K. International Publication.
	Reference Books:
1.	Hadi Sadat, **"Power System Analysis",** TMH, 2nd Edition.
2.	C.L.Wadhwa, **"Electrical Power system Analysis",** New Age publications.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc19_ee62/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Model** power systems & represent using line diagrams & impedance diagrams.	Re,Un, Ap	1,2,12	1,2
2.	**Explain** and **analyze** balanced and unbalanced systems, transients in power systems, symmetrical and unsymmetrical faults using symmetrical components and sequence networks.	Un, Ap, An	1,12	1,2
3.	**Explain** and **analyze** steady state and transient state stability of power systems using Swing equation and Equal area Criterion.	Un, An	1,2	1,2
4.	**Determine** Short circuit fault current, Short circuit MVA, Rating of circuit breakers.	Ap	1,2	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔	✔										✔	✔	✔		
2	✔	✔										✔	✔	✔		
3	✔	✔											✔	✔		
4	✔	✔											✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Modeling & analysis of Power Systems	Power Systems, Core Industries	Power System Engineer, Design Engineer, Lead Electrical Engineer, Entrepreneur

Internet of Things & Data Acquisition

Course Code	21EE52	**Course type**	**PCC**	**Credits L-T-P**	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Demonstrate an understanding of the basic principles of IoT, digitization and different IoT architectures.
2.	Understand and explain the smart objects, application of IoT in different industries.
3.	Understand, explain and apply Data and Analytics for IoT, IoT Physical Devices
4.	Design and demonstrate an understanding of IoT platforms.

Required Knowledge of : Basics of sensors, Automation

Unit – I	**Contact Hours = 8 Hours**
Introduction to IoT: Genesis of IoT, IoT and digitization, IoT impact, convergence of IT and IoT, IoT challenges, IoT network architecture and design, drivers behind new network architectures, comparing IoT architectures, a simplified IoT architecture, the core IoT functional stack, IoT data management and compute stack.	

Unit – II	**Contact Hours = 8 Hours**
Engineering IoT Networks: Smart objects: the "Things" in IoT, sensors, actuators, and smart objects, sensor networks, connecting smart objects, communications criteria, IoT access technologies. **IoT in Industry:** Utilities, smart and connected cities, transportation, public safety,	

Unit – III	**Contact Hours = 8 Hours**
Introduction to LoRa and LoRaWAN: LoRa & LoRaWAN, amplitude modulation, frequency modulation, frequency shift keying, chirp spread spectrum, LoRa spread spectrum modulation, LoRa applications, network coverage, low-power wide area networks, packet forwarders, hardware for end devices, hardware for gateways, LoRaWAN frequencies, LoRaWAN – Advantages and Features of LoRaWAN, LoRaWAN architecture - LoRaWAN Classes – class A, class B and class C devices, introduction to network server – introduction to application server - end device types and states – activation of ABP end devices – activation of OTAA end devices – received signal strength indicator (RSSI) – signal to noise ratio (SNR) – open Source LoRaWAN server integration	

Unit – IV	Contact Hours = 8 Hours
Data and Analytics for IoT Data and analytics for IoT, an introduction to data analytics for IoT, machine learning, big data analytics tools and technology, edge streaming analytics, network analytics, securing IoT, a brief history of OT security, common challenges in OT security, how IT and OT security practices and systems vary, formal risk analysis structures: OCTAVE and FAIR, the phased application of security in an operational environment.	

Unit –V	Contact Hours = 8 Hours
IoT Physical Devices and Endpoints - Arduino UNO: Introduction to arduino, arduino UNO, installing the software, fundamentals of arduino programming. IoT physical devices and endpoints RaspberryPi: introduction to RaspberryPi, about the RaspberryPi board: hardware layout, operating systems on RaspberryPi, configuring RaspberryPi, programming RaspberryPi with python, wireless temperature monitoring system.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
5	1	Arduino UNO demonstration
5	1	RaspberryPi demonstration
1 & 2	1	Real-time monitoring and measurement of weather data
1 & 2	1	Relay based real-time control of electrical equipment's.
1 & 2	1	Water level monitoring with buzzer
1 & 2	1	Automatic temperature controlling system
1 & 2	1	Flame detection and alerting system
4	1	Cloud connectivity and data analysis

Unit No.	Self-Study Topics
3	End Device Types and States – Activation of ABP End Devices – Activation of OTAA End Devices

Books	
	Text Books:
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,**"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things",** 1stEdition, Pearson Education (Cisco Press Indian Reprint). (**ISBN:** 978-9386873743).
2.	Srinivasa K G, **"Internet of Things",**CENGAGE Leaning India, 2017.
3.	Pradeeka Seneviratne, "Beginning LoRa Radio Networks with Arduino", APRESS, 2019.
	Reference Books:
1.	Raj Kamal, **"Internet of Things: Architecture and Design Principles",** 1st Edition, McGraw Hill Education, 2017. (**ISBN:** 978-9352605224)
2.	Miguel de Sousa, "Internet of things with Intel Galileo", PACKT publishing
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc19_cs65/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	**Explain** the basic principles of IoT, digitization and different IoT architectures.	Un	1,2,9,10	3
2.	**Explain** the smart objects, application of IoT in different industries.	App	2,4,9,10,12	3
3.	**Explain** and **analyze** Data and Analytics for IoT, IoT Physical Devices	App	2,4,9,10,12	3
4.	**Design** and **explain** different IoT platforms.	App	2,4,9,10,12	3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test (**COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)/ Course project	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batch wise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	√	√							√	√					√	
2		√		√					√	√		√			√	
3		√		√					√	√		√			√	
4		√		√					√	√		√			√	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Coding, Data structure handling Soft skill, managerial skill, etc	IT sector	Team Lead
2		Core companies	Developer, Project manager
3		Self employment(Start up)	Entrepreneur

Linear Integrated Circuits

Course Code	21EE53	Course type	PCC	Credits L-T-P	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the working of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, oscillators, filters, timers etc.
2.	To analyze/design the OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, oscillators, filters, timers etc
3..	To demonstrate the OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, oscillators, timers etc.

Pre-requisites : Analog Electronic circuits

Unit – I	Contact Hours = 8 Hours
Basics of OP-AMP and Op-Amp as amplifiers Integrated Circuits, Classification (Digital/Linear), Basic Op-Amp Circuit, Direct coupled versus capacitor coupled Amplifiers, OPAMP as voltage follower (Capacitor coupled) , high Zin capacitor coupled voltage follower, capacitor coupled non-inverting amplifier, capacitor coupled inverting amplifier. Single polarity Biasing arrangement.	

Unit – II	Contact Hours = 8 Hours
Op-Amp for signal processing applications Precision half wave & full wave rectifiers, Limiting circuits: Precision Clipper, Precision clamping circuits, voltage follower peak detectors, sample & hold circuit.	

Unit – III	Contact Hours = 8 Hours
Op-Amp for switching circuits Op-amps in switching circuits, zero crossing detectors, inverting Schmitt trigger circuits, non-inverting Schmitt circuits, astable multivibrator and monostable multivibrator.	

Unit – IV	Contact Hours = 8 Hours
Op-Amp for filters: First and second order high pass and low pass active filters, band pass filter, and band stop filter. **555 Timer and applications:** 555 Timer, modes of operation and its applications.	

Unit –V	Contact Hours = 8 Hours
Signal Generators: Triangular/rectangular waveform generator, waveform generator design, Wein bridge oscillator, oscillator amplitude stabilization, Colpitts Oscillator.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Design and implementation of capacitor coupled non-inverting amplifier with single polarity supply using 741 Op amp (Simulation/Hardware)
2	1	Design and implementation of Non Saturating Precision full wave rectifier, using 741 Op amp (Simulation/Hardware)
2	1	Design and implementation of Precision Clippers /Clampers circuits using 741 Op amp
3	1	Design and implementation of Inverting/Non inverting Schmitt Trigger Circuits using 741 Op amp (Simulation/Hardware)
4	1	555 Timer as Monostable Multivibrator (Simulation/Hardware)
4	1	555 Timer as Astable Multivibrator (Simulation/Hardware)
5	1	Design and implementation of square wave generator/ triangular wave generator using 741 Op-amp (Simulation/Hardware)
5	1	Design and implementation Wein bridge oscillator using 741 Op-amp (Simulation/Hardware)

Unit No.	Self-Study Topics
1	Nil
2	voltage follower peak detectors
3	Nil
4	band pass filter, band stop filter
5	Colpitts Oscillator.

Books	
	Text Books:
1.	David A. Bell , Operational amplifiers and linear IC's, Oxford University Press, Edition-2011/Impression-2018
2.	Ramakant A. Gayakwad, OP-AMP and Linear Integrated Circuits, Pearson India Education Services, Published in 2015/ Impression-2017
	Reference Books:
1.	Robert L. Boylestad, Louis Nashelsky, Electronics Devices and Circuit Theory, Pearson, Eleventh Edition onwards
2.	David A. Bell, "Electronic Devices and Circuits", PHI, 4th Edition and onwards
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc23_ee65/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Explain the basics of IC's and operation of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, oscillators, filters, timers etc.	Un	1,5,9,10,12	1,3,4
2.	Analyze/ Design the circuit models of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, filters, oscillators, timers etc.	Ap-An-Ev	1 2,5,9,10,12	1,3,4
3.	Develop/Demonstrate the circuit models of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, filters, oscillators, timers etc.	Ap-An-Ev	1,2,5,9,10,12	1,3,4

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)/ Course project	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batch wise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

	CO-PO Mapping (planned)												**CO-PSO Mapping(planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✓				✓				✓	✓		✓	✓		✓	✓
2	✓	✓			✓				✓	✓		✓	✓		✓	✓
3	✓	✓			✓				✓	✓		✓	✓		✓	✓
	Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Analysis and Design of OpAmp/555-Timer application circuits,	IC design, VLSI, Embedded systems, different fields involving electronics circuits	Circuit design Engineer, Analog Design Engineer, Junior Engineer, PCB design,
2	Demonstration of circuits with OPAMP, other active/passive elements.		

FUZZY LOGIC

Course Code	21EEPE541	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the basic principles of crisp and fuzzy sets.
2.	Summarize theory of approximate reasoning and justify the use of the rules.
3.	Analyze and summarize the FKBC structure and understand the concept of fuzzification and defuzzification
4.	Design a typical fuzzy logic controller for various applications.
5.	Understand the concepts of adaptive mechanism for the fuzzy based controllers.

Pre-requisites : Set Theory

Unit – I	Contact Hours = 8 Hours
The mathematics of fuzzy control: Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle	

Unit – II	Contact Hours = 8 Hours
Theory of approximate reasoning: Linguistic variables, Linguistic Hedges, Fuzzy proportions, Fuzzy if-then, if_then_else statements, inference rules, compositional rule of inference.	

Unit – III	Contact Hours = 8 Hours
Fuzzy knowledge-based controllers (FKBC): Basic concept of structure of FKBC, choice of membership functions, scaling factors, rules, fuzzification and defuzzification procedures.	

Unit – IV	Contact Hours = 8 Hours
Applications: Simple applications of FKBC such as washing machines, traffic regulations, lift control, aircraft landing Control, speed control of DC motor, Water level control, temperature control, economical load scheduling, unit commitment, Maximum power point tracking for solar panel.	

Unit –V	Contact Hours = 8 Hours
Adaptive fuzzy control: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria, model based controller.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	nil	nil	nil	nil	nil

Books	
	Text Books:
1.	M Timothy John Ross, "Fuzzy Logic With Engineering Applications", Wiley, Second Edition, 2009.
2.	D. Driankov, H. Hellendoorn and M. Reinfrank , "An Introduction to Fuzzy Control", Narosa Publishers India, 1996.
	Reference Books:
1.	G. J. Klir and T. A. Folger, "Fuzzy Sets Uncertainty and Information", PHI IEEE, 2009
2.	R. R. Yaser and D. P. Filer, "Essentials of Fuzzy Modeling and Control, John Wiley, 2007.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108104157

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the basic concepts of fuzzy sets, operations, properties of fuzzy sets, fuzzy relations, basic features of membership functions, fuzzification process and defuzzification process, and adaptive fuzzy logic.	Un	1,2,3	1
2.	Apply the composition and fuzzy rules to the real world problems.	Ap	1,2,3	1
3	Design &Develop the fuzzy systems for real-world applications	Cr	1,2,3,5,9, 10	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
✔	✔	✔	✔										✔		
✔	✔	✔	✔										✔		
✔	✔	✔	✔		✔				✔	✔			✔		
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Logical thinking, implementation of controller logic, model developing using fuzzy systems.**	**R&D, Electronics, Control Systems**	**R&D Engineer**

PLC and Industrial Automation

Course Code	21EEPE542	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To demonstrate an understanding of the basics of PLC, architecture, hardware and I/O devices.
2.	To understand and explain ladder programming, logic functions, latching, multiple outputs, functional blocks and emergency switches.
3.	To demonstrate an understanding of instruction list, sequential functions charts & structured text, subroutines.
4.	To demonstrate an understanding of Ladder programs and control relay.
5.	To demonstrate an understanding of different type of timers and counters, programming with timers and counters.

Pre-requisites: Basics of Electrical and Electronics Engineering, Logic Gates, Relay Technology.

Unit – I INTRODUCTION TO PLC	Contact Hours = 8 Hours
Introduction to Programmable logic controller (PLC), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs I/O addresses.	

Unit – II PROGRAMMING	Contact Hours = 8 Hours
Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, program examples like location of stop and emergency switches.	

Unit – III PROGRAMMING LANGUAGES	Contact Hours = 8 Hours
Instruction list, sequential functions charts & structured text, jump and call subroutines.	

Unit – IV INTERNAL RELAYS	Contact Hours = 8 Hours
Ladder programs, battery- backed relays, one - shot operation, set and reset, master control relay.	

Unit – V TIMERS AND COUNTERS	Contact Hours = 8 Hours
Types of timers, programming timers, ON and OFF- delay timers, pulse timers, forms of counter, programming, up and down counters, timers with counters, sequencer.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	Nil	Nil	Nil	Nil	Nil

Books	
	Text Books:
1.	**Programmable Logic controllers**-W Bolton, 5th edition, Elsevier- newness, 2009.
2.	**Programmable logic controllers - principles and applications"**-John W Webb, Ronald A Reis, Pearson education, 5th edition, 2nd impression, 2007.
	Reference Books:
1.	**Programmable Controller Theory and Applications**, L. A Bryan, E. A Bryan, An industrial text company publication, 2nd edition, 1997.
2.	**Programmable Controllers, An Engineers Guide**-E. A Paar, newness, 3rd edition, 2003.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain basics of PLC, architecture, hardware and I/O devices.	Re, Un	1,2	1
2.	Explain ladder programming, logic functions, latching, multiple outputs, functional blocks and emergency switches.	Un, Ap	1,2,3,5,6	1,2,3
3.	Explain instruction list, sequential functions charts & structured text, subroutines.	Un,Ap	1,2,3,4,5,6	1,2,3
4.	Write ladder programs and explain control relay.	Ap, An	1,2,3,4,5,10,11	1,2,3
5.	Explain different type of timers and counters, programming with timers and counters.	Un, Ap, An	1,2,3,4,5,10,11	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	√	√											√			
2	√	√	√		√	√							√	√	√	
3	√	√	√	√	√	√							√	√	√	
4	√	√	√	√	√					√	√		√	√	√	
5	√	√	√	√	√					√	√		√	√	√	
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	PLC Programming	Manufacturing Industry	PLC Programmer/Engineer
2	Industrial Networking	Automotive Industry	Automation Engineer, Control Systems Engineer
3	HMI and SCADA Systems	Energy and Utilities, Oil and Gas Industry	SCADA Engineer, Instrumentation Engineer
4	Control System Design	Pharmaceutical and Chemical Industry, Food and Beverage Industry	Field Service Engineer, Robotics Engineer, Process Control Engineer.
5	Troubleshooting and Maintenance, Safety and Compliance	Water and Wastewater Treatment, Building Automation	Industrial Network Engineer, Project Engineer/Manager

NETWORK ANALYSIS

Course Code	21EEPE543	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understanding the basic concepts and types of Electric networks, basic tools of network analysis and apply them for the real time problems.
2.	To understand the useful tools like network theorems and their applications in network analysis.
3.	To demonstrate an understanding of the concept and analysis of Series and Parallel resonant circuits and the practical applications.
4.	To understand the concept of switching, behavior of electric network parameters during switching, transient and steady state response of typical electric networks using Laplace transformation tools.
5.	To understand the modeling of Two port electric networks and applications

Pre-requisites : Calculus, Differential equations, Laplace transformation, Basic Electrical Engineering

Unit – I	Contact Hours = 8 Hours
Basic Concepts: Practical sources, Source transformations, Network reduction using Star – Delta transformation, Loop and Node analysis for linear DC and AC networks with dependent and independent sources, Concepts of super node and super mesh. Principle of duality	

Unit – II	Contact Hours = 8 Hours
Network Theorems – Superposition, Reciprocity and Millman's theorems Thevenin's and Norton's theorems, Maximum Power transfer theorem	

Unit – III	Contact Hours = 8 Hours
Resonant Circuits: Series resonance and parallel resonance, frequency- response of series and Parallel circuits, Q –factor, Bandwidth. **Transient behavior and initial conditions**: Behavior of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations	

Unit – IV	Contact Hours = 8 Hours
Laplace Transformation & Applications: Basic signals and waveform synthesis, Laplace transformations, Determination of time response of networks with step, ramp and impulse inputs, sinusoidal and synthesized inputs	

Unit – V	Contact Hours = 8 Hours
Two port network parameters: Definition of z, y, h and transmission parameters, modeling of two port networks with these parameters, inter relationship between parameters sets.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Roy Choudhury, Networks and systems, New Age International Publications, 2nd edition,
2.	Hayt, Kemmerly and Durbin, Engineering Circuit Analysis, TMH 7th Edition, 2010.
	Reference Books:
1.	M. E. Van Valkenburg, Network Analysis, PHI / Pearson Education, 3rdEdition.
2.	A.Chakrabarti, Circuit Theory**(**Analysis and Synthesis**),** Dhanpat Rai & Co.,2010.
	E-resources (NPTEL/SWAYAM.. Any Other)
1.	https://archive.nptel.ac.in/courses/108/105/108105159/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Apply** the basic concepts and basic tools of network analysis for the real time analysis problems in different types of Electric networks**.**	Ap	1,2,4, 12	1,2
2.	**Apply** useful tools like network theorems for various **applications** of network analysis in Electric networks**.**	Ap	1,2,4, 12	1,2
3.	**Analyze** Series and Parallel resonant circuits and apply for the practical applications.	An	1,2,4, 12	1,2
4.	**Understand** and **analyze** transient and steady state response of typical electric networks for different types of input signals using Laplace transformation tools**.**	Un, An	1,2,12	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	√	√		√								√	√	√		
2	√	√		√								√	√	√		
3	√	√		√								√	√	√		
4	√	√		√								√	√	√		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Analysis of circuits & Power Systems	Core Industries, Design and Planning	Maintenance & Design Engineer

OOP with C++

Course Code	21EEPE544	Course type	PEC	Credits L-T-P	2 - 0 - 1
Hours/week: L - T- P	2- 0 - 2			Total credits	3
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 10 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To Understand Object-Oriented Programming concepts.
2.	To Understand the importance of inline and virtual functions.
3.	To study about constructor, destructor and its usage.
4.	To study the importance of inheritance, polymorphism in C++.

Required Knowledge of : C Programming

Unit – I	Contact Hours = 6 Hours
Introduction to Object Oriented Programming: Computer programming background, C++ overview, what is an object, Classes and methods, abstraction, encapsulation, inheritance and polymorphism., first C++program, C++ syntax, Tokens, Keywords, Identifiers, constants and Operators in C++, Scope resolution operator, Expressions and their types, Special assignment expressions.	

Unit – II	Contact Hours = 6 Hours
Functions in C++: – Functions, Inline function, function overloading, friend and virtual functions, specifying a class, C++ program with a class, arrays within a class, Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors.	

Unit – III	Contact Hours =6 Hours
Inheritance: Derived Classes, Single inheritance, multiple inheritance, Hierarchical, Inheritance, Hybrid Inheritance, Pointers to objects and derived classes, this pointer.	

Unit – IV	Contact Hours = 6 Hours
Polymorphism: Polymorphism, Types of polymorphism, Function overloading, defining operator overloading, Overloading Unary and binary operators, Virtual and pure virtual functions.	

Unit – V	Contact Hours = 6 Hours
Exception Handling: Introduction to Exception, Benefits of Exception handling, Try and catch block, Throw statement, pre-defined exceptions in C++.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**1**	Program to sort the elements in ascending and descending order.
1	**1**	Program to find the sum of all the natural numbers from 1 to n.
1	**1**	Program to swap 2 values by writing a function that uses call by reference technique.
2	**1**	Program to demonstrate function overloading.
2	**1**	Program to demonstrate Inheritance.
3	**1**	Program to demonstrate multilevel inheritance.
5	**1**	Program to demonstrate usage of try, catch and throw to handle exception.
5	**1**	Program function to demonstrate array of bounds exception .

Unit No.	Self-Study Topics
1	Escape Sequence in C++
2	Inline functions and Macros
3	Ambiguity in multiple inheritance
4	Run time polymorphism
5	Exceptions in Constructors and Destructors

Books	
	Text Books:
1.	Balagurusamy E, Object Oriented Programming with C++, Tata McGraw Hill Education Pvt.Ltd , Fourth Edition 2010
2.	Herbert Schildt, “The Complete Reference C++”, 4th Edition, Tata McGraw Hill.
	Reference Books:
1.	Robert Lafore ,“Object-Oriented Programming in C++”, Fourth Edition, Sams Publications.
2.	Stanley B.Lippmann, JoseeLajore, “C++ Primer”, 4th Edition, Pearson Education
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.swayam2.ac.in/aic20_sp01/course
2.	https://onlinecourses.swayam2.ac.in/aic20_sp06/course

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the basic concepts of Object-Oriented programming	Re, Un	1,5	3
2.	Make use of the functions for modularity.	Un, Ap	1,2,5	3
3.	Implement the concepts of Object oriented programming such as polymorphism, Inheritance.	Un, Ap	1,2,3,4, 5	3
4.	Implement the concept of Exception Handling	Un, Ap	1,2,3,4, 5	3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Algorithms, Sample Input/Output,, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batch wise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Algorithms , Sample Input/output, results and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (planned)													CO-PSO Mapping (planned)			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	√				√										√	
2	√	√			√										√	
3	√	√	√	√	√										√	
4	√	√	√	√	√										√	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Develop Logic, Flowcharts, Source codes , Debugging, Designing SCADA systems	IT Industries, Automation	Software Engineer, Maintenance & Automation Engineer,

Electrical Measurements & Instrumentation

Course Code	21EEPE545	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	50
Flipped Classes content	--			SEE Marks	50

Course learning objectives	
1.	Understand the Measuring of resistance, inductance and capacitance using bridges and determine earth resistance.
2.	Explain the working of various meters used for measurement of Power, Energy & understand the adjustments, calibration & errors in energy meters.
3.	Understand methods of extending the range of instruments & instrument transformers.
4.	Explain the working of different electronic instruments, display and recording devices

Pre-requisites: Basic Electrical Engineering, Mathematics, Electronics, Instrumentation Basics.

Unit – I	Contact Hours = 8 Hours
Measurement of Resistance: Wheatstone's bridge, sensitivity, limitations, Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Megger. **Measurement of Inductance and Capacitance:** Sources and detectors, Maxwell's inductance and capacitance bridge, Hay's bridge, Anderson's bridge, Desauty's bridge, Schering bridge. Shielding of bridges, Problems.	

Unit – II	Contact Hours = 8 Hours
Measurement of Power, Energy, Power Factor and Frequency: Torque expression, Errors and minimization, UPF and LPF wattmeter. Measurement of real and reactive power in 3 phases circuits, Errors, adjustments and calibration of single and three phase energy meters, Problems. Construction and operation of single-phase and three phase dynamometer type power factor meter, Weston frequency meter and phase sequence indicator.	

Unit – III	Contact Hours = 8 Hours
Extension of Instrument Ranges: Desirable features of ammeters and voltmeters. Shunts and multipliers, Construction and theory of instrument transformers, Desirable characterizes, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee's method of testing CT. **Magnetic measurements:** Introduction, measurement of flux/ flux density, magnetizing force and leakage factor.	

Unit – IV	Contact Hours = 8 Hours
Electronic and Digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments, True rms reading voltmeter, Electronic multimeters. Digital voltmeters (DVM) - Ramp type DVM, Integrating type DVM and Successive - approximation DVM, Q meter, Principle of working of electronic energy meter (with block diagram), extra features offered by present day meters and their significance in billing.	

Unit –V	Contact Hours = 8 Hours
Display Devices: Introduction, character formats, segment displays, Dot matrix displays, Bar graph displays. Cathode ray tubes, Light emitting diodes, Liquid crystal displays, Nixes, Incandescent, Fluorescent, Liquid vapour and Visual displays. **Recording Devices:** Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and recorders. Digital tape recording, Ultraviolet recorders, Electro Cardio Graph (ECG)	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	Nil	Nil	Nil	Nil	Nil

Books	
	Text Books:
1.	Electrical and electronic Measurements and Instrumentation A.K. Sawhney Dhanpat Rai and Co 10th Edition
2.	A Course in Electronics and Electrical Measurements and Instrumentation J. B. Gupta Katson Books 2013 Edition
	Reference Books:
1.	Electrical and electronic Measurements and Instrumentation R.K. Rajput S Chand 5th Edition, 2012
2.	Electrical Measuring Instruments and Measurements S.C. Bhargava BS Publications 2013
3.	Modern Electronic Instrumentation and Measuring Techniques Cooper D and A.D. Heifrick Pearson First Edition, 2015
4.	Electronic Instrumentation and Measurements David A Bell Oxford University 3rd Edition, 2013
5.	Electronic Instrumentation H.S.Kalsi Mc Graw Hill 3rd Edition,2010

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Measure resistance, inductance and capacitance using bridges and determine earth resistance.	Re, Un	1,6,9	1
2.	Explain the working of various meters used for measurement of Power, Energy & understand the adjustments, calibration & errors in energy meters.	Re, Un, An	1,2,5,7	1,2,3
3.	Understand methods of extending the range of instruments & instrument transformers.	Re, Un	1,2,3,10	1,2,3
4.	Explain the working of different electronic instruments, display and recording devices	Re, Un	1,2,7	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√					√			√				√		
2	√	√			√		√						√	√	√
3	√	√	√							√			√	√	√
4	√	√					√						√	√	√
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Measurement Techniques	Electrical Engineering	Test Engineer
2	Instrumentation Knowledge	Power Generation and Distribution	Calibration Technician
3	Calibration and Metrology	Electronics and Semiconductor Manufacturing, Telecommunications and Networking	Instrumentation Engineer, Research and Development Engineer, Quality Assurance Engineer
4	Transducers and Sensors	Industrial Automation and Control Systems	Field Service Engineer
5	Measurement System Design	Renewable Energy, Research and Development	Automation Engineer, Power Systems Engineer
6	Troubleshooting and Maintenance	Aerospace and Defense, Automotive Engineering, Quality Control and Compliance	Technical Sales Engineer, Consulting Engineer

RENEWABLE ENERGY SOURCES

Course Code	21EEOE551	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
To impart an ability to the students to	
1.	To explain the aspects of the energy situation in India
2.	To understand of the measurement of solar energy and technical and economic aspects of solar thermal energy.
3.	To explain different methods of extraction of solar energy and necessity of energy storage and methods of Energy Storage.
4.	To Explain concept of energy conversion process from biomass and construction of different biomass plants.
5.	To analyze power availability in the wind and measurement and audit of wind energy and energy conversion.

Pre-requisites: Basic electrical engineering.

Unit – I	Contact Hours = 8 Hours
Energy sources: Introduction, importance of energy consumption as measure of prosperity, per capita energy consumption, classification of energy resources, advantages, limitations; comparison of conventional and non-conventional energy resources; world energy scenario; Indian energy scenario. **Solar energy basics:** Introduction, solar constant, basic sun-earth angles – definitions and their representation, solar radiation geometry (numerical problems), estimation of solar radiation of horizontal and tilted surfaces (numerical problems); measurement of solar radiation data – Pyranometer and Pyrheliometer.	

Unit – II	Contact Hours = 8 Hours
Solar electric systems energy storage: Solar thermal electric power generation – solar pond and concentrating solar collector (parabolic trough, parabolic dish, Central Tower Collector). Advantages and disadvantages. **Solar PV Systems**: Solar cell fundamentals, characteristics, classification, construction of module, panel and array, stand-alone and grid connected; Applications – Street lighting, domestic lighting and solar water pumping systems.	

Unit – III	Contact Hours = 8 Hours
Thermal systems: Principle of conversion of solar radiation into heat, solar water heaters (Flat Plate Collectors), solar cookers – Box type, concentrating dish type, solar driers, solar still, solar furnaces, solar green houses. **Biomass energy:** Introduction, Photosynthesis process, biomass fuels, biomass conversion technologies, urban waste to energy conversion, biomass gasification, biomass to ethanol production, biogas production from waste biomass, factors affecting biogas generation, types of biogas plants – KVIC and Janata model; Biomass program in India.	

Unit – IV	Contact Hours = 8 Hours
Wind energy: Introduction, wind and its properties, wind energy scenario – World and India. Basic principles of Wind Energy Conversion Systems (WECS),classification of WECS, parts of WECS, Types of Wind Generators, derivation for Power in the wind, wind site selection consideration, advantages and disadvantages of WECS.	

Unit – V	Contact Hours = 8 Hours
Batteries and fuel cells: storage cell fundamentals, Emerging trends in batteries, storage cell definitions and specifications, fuel cell fundamentals, The alkaline fuel cells, Acidic fuel cells, SOFC – emerging areas in fuel cells, Applications – Industrial and commercial. Cogeneration using bagasse - Combustion of rice husk, Solar Roof top, Energy conservation in cooling towers and spray ponds, solar water heating.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	G.D. Rai,"Non-Conventional Sources of Energy", 4th Edition, Khanna Publishers, New Delhi, 2007.
2.	Khan B. H., "Non-Conventional Energy Resources",TMH, New Delhi, 2006.
3.	David Linden and Thomas. B. Reddy, "Hand Book of Batteries and Fuel cells", 3rd Edition, McGraw Hill Book Company, N. Y. 2002.
	Reference Books
1.	Mukherjee, D., and Chakrabarti, S.,"Fundamentals of Renewable Energy Systems", New Age International Publishers, 2005.
2.	Xianguo Li, "Principles of Fuel Cells", Taylor & Francis, 2006.
	E-resources (NPTEL/SWAYAM.. Any Other)
1.	https://nptel.ac.in/courses/103103206
2.	https://onlinecourses.nptel.ac.in/noc23_ch35/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the renewable energy concept.	Un	1,6,7,9,10,11,12	1,2,4
2.	Explain the power generation by various renewable energy sources	Un	1,6,7,9,10,11,12	1,2,4
3.	Plan & Design Solar & Wind energy systems.	Cr	1,3,6,7,9,10,11,12	1,2,4

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✓					✓	✓		✓		✓	✓	✓	✓		✓
2	✓					✓	✓		✓		✓	✓	✓	✓		✓
3	✓		✓			✓	✓		✓		✓	✓	✓	✓		✓
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Designing of Solar Application	Solar & Wind Power industry	Design/Site Engineer
2	Renewable Energy Consultant	Renewable Industry	Energy Consultant

Special Electrical Machines

Course Code	21EEOE552	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To demonstrate an understanding of the principle of operation, construction, control and performance of stepping motor.
2.	To understand and explain Construction, principle of operation, control and performance of switched reluctance motors.
3.	To demonstrate an understanding of Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
4.	To demonstrate an understanding of Construction, principle of operation and performance of permanent magnet synchronous motors.
5.	To demonstrate an understanding of principle of operation, construction and performance of synchronous reluctance motors.

Pre-requisites: Basic Electrical Engineering, Electrical Machines.

Unit – I: Stepping Motors	**Contact Hours = 8 Hours**
Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Concept of lead angle - Applications.	

Unit – II: Switched Reluctance Motors	**Contact Hours = 8 Hours**
Constructional features–Principle of operation–Torque prediction– Steady state performance prediction-Analytical method-Power Converters and their controllers – Sensor less operation – Closed loop control of SRM - Characteristics.	

Unit – III: Permanent Magnet Brushless D.C.Motors	**Contact Hours = 8 Hours**
Permanent Magnet materials– Magnetic Characteristics – Principle of operation–Types– Magnetic circuit analysis–EMF and torque equations –Commutation- Power controllers–Motor characteristics – Applications.	

Unit – IV: Permanent Magnet Synchronous Motors	**Contact Hours = 8 Hours**
Principle of operation–Ideal PMSM –EMF and Torque equations–Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics- Power controllers- Converter Volt-ampere requirements – Applications.	

Unit – V: Synchronous Reluctance Motors	Contact Hours = 8 Hours
Constructional features–Types–Axial and Radial flux motors–Operating principles–Variable Reluctance and Hybrid Motors–SYNREL Motors–Voltage and Torque Equations- Phasor diagram - Characteristics.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	E.G.Janardanan, "Special Electrical Machines", PHI learning Private Limited, 2016
2.	T.J.E.Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press,Oxford, 1989.
3.	K.Venkataratnam, "Special Electrical Machines", Universities Press (India) Private Limited, 2008.
4.	T.Kenjo, "Stepping Motors and their Microprocessor Controls", Clarendon Press London, 1984.
	Reference Books:
1.	R. Krishnan "Switched Reluctance Motor Drive-modeling, Simulation, Analysis, Design and Application", CRC Press,NewYork,2001.
2.	P.P.Aearnley, "Stepping Motors–A Guide to Motor Theory and Practice", Peter Perengrinus London, 1982.
3.	R.Srinivasan, "Special Electrical Machines", Lakshmi Publications, 2013.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** principle of operation and construction of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors.	Re, U	1, 2, 12	2
2.	**Understand** and **Explain** the performance and control circuit of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors and permanent magnet synchronous motors.	Un, Ap	1, 2, 12	2, 3
3.	**Understand** and **Demonstrate** the applications of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors and permanent magnet synchronous motors.	Un, Ap	1, 2, 12	2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔	✔										✔		✔		
2	✔	✔										✔		✔	✔	
3	✔	✔										✔		✔		
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Enhanced knowledge about advanced machines**	**Core Industries, EVs, Railways**	**Maintenance, Automation & Design Engineer**

Industrial Motors

Course Code	21EEOE553	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hr			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand and explain the four quadrant operation of an electric motor.
2.	Understand and apply electrical braking of electric motors.
3.	Describe and analyze the techniques of DC motor control.
4.	Describe and analyze the techniques of Induction motor control and Synchronous Motor.

Pre-requisites : Basic Electrical Engineering

Unit – I	Contact Hours = 8 Hours
Electrical Drives and Dynamics: Introduction to Electrical Drives, advantages of electrical drives. Parts of electrical drives. Choice of electrical drive. Fundamental torque equation , Multi quadrant operation. Equivalent values of drive parameters. Components of load torque. Nature and classification of load torque. Steady state stability, Load equalization.	

Unit – II	Contact Hours = 8 Hours
Rating and Braking of Motor: Thermal model of motor for heating and cooling (only Analysis – No numerical examples) Classes of motor duty cycle. Determination of motor rating. Braking of DC motor. Braking of 3 phase induction motor.	

Unit – III	Contact Hours = 8 Hours
DC Motors: Methods of speed control of different types of DC motor, selection of DC motors, power rating selection of different types DC motors	

Unit – IV	Contact Hours = 8 Hours
Induction Motor: Operation with unbalanced source voltage and single phasing, variable voltage, variable frequency control, methods of speed control, selection and power rating selection of different types induction motors.	

Unit – V	Contact Hours = 8 Hours
Synchronous Motor: Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless DC Motor Drives. Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping Rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	G.K. Dubey, “Fundamentals of Electrical Drives” , Narosa Publications.
2.	S.L. Uppal “ Electrical Power” Khanna Publishers.
	Reference Books:
1.	S.K. Pillai, “ First Course in Electrical Drives” TMH Publications.
2.	N.K. De and P.K. Sen, “Electric Drives” , TMH Publication.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc23_ee140/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the four quadrant operation of electric motor.	Un	1,2	3
2.	**Explain** and **analyze** electrical braking of electric motor.	An	2,4,12	3
3.	**Explain** and **analyze** the techniques of DC motor control.	An	2,4,12	3
4.	**Describe** and **analyze** the techniques of Induction motor control and Synchronous Motor.	An	2,4,12	3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO 4**
1	√	√													√	
2		√		√								√			√	
3		√		√								√			√	
4		√		√								√			√	
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Modeling & analysis of electric motors**	**Core Industries**	**Design Engineer, Lead Engineer, Entrepreneur**

Introduction to Astronomy

Course Code	21PH551	Course type	Open elective	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To review concepts in physics required in astronomy.
2.	To understand energy generation, transport in stars and end states of a star.
3.	To comprehend HR diagram, evolution of stars and binary systems.
4.	To understand structure of galaxies, milky way and the expansion of the universe. To study cosmology and the big bang model.

Pre-requisites : None

Unit – I	Contact Hours = 8 Hours
The universal law of Gravitation, Conservation of energy, Electric force, Relative strength of electric and gravitational forces, Electromagnetism, Nuclear Forces, Quantum mechanical behaviour of light and matter, Hydrogen atom spectrum, orbital angular momentum, spin angular momentum, quantum statistics, atomic spectroscopy, special theory of relativity, time dilation, Length contraction, Relativistic Doppler effect, Relativistic mass, Mass-energy equivalence, thermodynamics , statistical mechanics, perfect gas, Thermodynamic behaviour of radiation, Introduction to reflective and refractive telescope.	

Unit – II	Contact Hours = 8 Hours
The source of energy in the sun, the stability of the sun, the principles of stellar structure, the radiative and convection zone of the sun, The atmosphere of the sun –Radiative transfer in the sun, the chromospheres and corona of the sun, magnetic activity in the sun, Matter and four forces, The strong and weak nuclear forces, Atomic nuclei, Binding energy of atomic nuclei, Thermonuclear reactions, The end states of a star- White dwarfs, Neutron star and Black hole.	

Unit – III	Contact Hours = 8 Hours
Evolution of stars-Theoretical H-R diagram, Evolution of low mass stars, Evolution of high mass stars, Observational H-R diagram, The H-R diagram of nearby stars, The H-R diagram of nearby star clusters, Classification and formation of binary stars, examples of close binary stars.	

Unit – IV	Contact Hours = 8 Hours
Interstellar dust and gas, Gaseous Nebulae, Cosmic rays and interstellar magnetic field, stars and interstellar medium, Milky way, stellar population, Differential rotation of galaxy, spiral structure, interacting binary galaxies, mergers, the expansion of the universe.	

Unit –V	Contact Hours = 8 Hours
Newtonian cosmology, General relativity and cosmology, Large scale geometry of space and time, The Big bang vs. steady state, The hot big bang, The creation of material world.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Frank H. Shu, The Physical Universe- An introduction to Astronomy, University Science books, 1st edition and onwards
	Reference Books:
1.	M.Harwit , Astrophysical Concepts , Springer, 4th edition and onwards
2.	M. Stix, The Sun : An Introduction, Springer, 2nd edition and onwards
3.	K.D. Abhyankar, Astronomical Physics : Stars and Galaxies, University press, 1st edition and onwards
4.	Karttunen, Fundamental astronomy, Springer, 4th edition and onwards

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply nuclear physics, statistical physics to understand working and end states of stars.	Ap	1	1
2.	Understand classification of stars and binary systems.	Un	1	1
3.	Understand structure of galaxy and expansion of the universe	Un	1	1
4.	Apply general relativity to understand cosmology	Ap	1	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Project	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Understanding of various types, motion of celestial objects and its observation techniques**	**Research in astronomy, space science**	**Engineer at research institutes in the field of astronomy, engineers at ISRO.**

PLC & SCADA

Course Code	21INT52	Course type	OEC	Credits L-T-P	2 – 0 - 2
Hours/week: L-T-P	2 – 0 – 2			Total credits	3
Total Contact Hours	L = 25 Hrs; T = 0 Hrs; P = 15 Hrs Total = 40 Hrs			CIE Marks	50
Flipped Classes content	-			SEE Marks	50

Course learning objectives	
1.	Understand the PLC means and Technical definition of PLC.
2.	Understand different languages used in PLC programming. Block diagram of PLC.
3.	Explain and understand the different Logic gates, identification of Input and output addressing.
4.	Explain and understand SCAN time in PLC.
5.	Explain and understand types and functions of Timers and Counters.
6.	Explain and understand different functions and mathematical blocks.
7.	Explain and Understand different expansion modules and IO mapping / addressing.
8.	Definition of SCADA, generation of SCADA. SCADA systems used in different fields of Automation.

Pre-requisites: PLC Ladder software and videos.

Unit – I	Contact Hours = 8 Hours
What is A PLC, Technical Definition of PLC, What are its advantages, characteristics functions of A PLC, Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Different Languages of PLC. Equivalent Ladder diagram of AND gate OR Gate, OR Gate, NOT Gate XOR Gate, NAND Gate, NOR Gate.	

Unit – II	Contact Hours = 8 Hours
Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Ladder design, Sinking and sourcing. Experiment on Logic Gates / DOL starter **Case Study** - Design Thinking and Execution with practical experiments	

Unit – III	Contact Hours = 8 Hours
PLC Timers and Counters: Retentive and non-retentive timers. Timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Count down (CTD). Advanced instructions: Introduction: Comparison instructions, discussions on comparison Instructions, “EQUAL” or “EQU” instruction, “NOT EQUAL” or “NEQ” instruction, “LESS THAN” or “LESS” instruction, “LESS THANOR EQUAL’ or “LEQ” instruction, GREATER THAN” OR “GRT” instruction, “GREATER THAN OR EQUAL TO” or “GRO” instruction, “MASKED COMPARISON FOR EQUAL” or “MEQ” instruction, “LIMIT TEST” or “LIM” Instruction. Functional block diagram and sequential ladder diagram. Experiment on Timers / Counters. **Case Study** - Design Thinking and Execution with practical experiments.	

Unit – IV	Contact Hours = 8 Hours
PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O. Types of Analog input modules, special input modules and Analog output module. Experiment on Parking, Analog Block **Case Study** - Design Thinking and Execution with practical experiments.	

Unit –V	Contact Hours = 8 Hours
SCADA SYSTEMS Introduction, definition of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First generation-Monolithic, Second Generation-Distributed, Third generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Water Purification System, Hydraulic Test Rig, Power System Automation, Petroleum Refining Process, Chemical Plant. SCADA of different projects done. Practical on how to develop small SCADA screen.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	NIL	NIL	NIL	NIL	NIL

Books	
	Text Books:
1.	Industrial handbooks, catalogue and data sheets for respective material/system of reputed make
2.	Beginners Guide to PLC programming- Neal Babcock
3.	Programmable Logic Controllers-Kelvin T Erickson.
	Reference Books:
1.	Programmable Controllers, An Engineers Guide-E. A Paar, newness, 3rd edition, 2003.
	E-resourses (NPTEL/SWAYAM.. Any Other)
1.	www.instrumentationtools.com

Course delivery methods		Assessment methods	
1.	PPT and Videos	1.	IA tests
2.	Factory Visits for Practical	2.	Online Quizzes (Surprise and Scheduled)
3.		3.	Open Book Tests (OBT)
4.		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain PLC, Different Languages of PLC, Block diagram of PLC, advantages / disadvantages of PLC	Re, Un	1,2	1
2.	Logic Gates, Sink/Source, PNP/NPN functions, I/O addressing in the PLC, DOL/Logic Gates Practicals	Un, Ap, Ev, Cr	1,2,3,4,5,10,11	1,2,3
3.	Understand of Timers, Counters, Mathematical Instructions, Comparison Instructions, different Practicals	Un, Ap, Ev, Cr	1,2,3,4,5,10,11	1,2,3
4.	Addressing of PLC, Expansion I/O modules, Analog Modules, Power supply,	Re, Un	1,2	1
5.	What is SCADA, advantages of SCADA, different Generations of SCADA	Re, Un	1,2	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	5* 2 marks = 10	10+10 =20	20	100

OBA- Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	SEE exam is practical; it will be conducted for 3 hours duration and for 50 marks.
2.	Minimum passing marks required to be scored in SEE; 20 out of 50 marks.
3.	Question paper will have 20 Quiz questions carrying 20 marks and 2 Practical questions carrying 15 marks each.
4.	Student can change the 1 practical question by deducting 5 marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	√	√											√			
2	√	√	√	√	√						√	√	√	√	√	
3	√	√	√	√	√						√	√	√	√	√	
4	√	√											√			
5	√	√											√			
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	PLC Programming	Manufacturing Industry	PLC Programmer/Engineer
2	Industrial Networking	Automotive Industry	Automation Engineer, Control Systems Engineer
3	HMI and SCADA Systems	Energy and Utilities, Oil and Gas Industry	SCADA Engineer, Instrumentation Engineer
4.	Control System Design	Pharmaceutical and Chemical Industry, Food and Beverage Industry	Field Service Engineer, Robotics Engineer, Process Control Engineer.
5.	Troubleshooting and Maintenance, Safety and Compliance	Water and Wastewater Treatment, Building Automation	Industrial Network Engineer, Project Engineer/Manager

RESEARCH METHODOLOGY& INTELLECTUAL PROPERTY RIGHTS

Course Code	21AECEE57	Course type	AEC	Credits L-T-P	1 – 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 15Hrs; T = 0 Hrs; P = 0 Hrs Total = 15Hrs			CIE Marks	50
Flipped Classes content	3 Hours			SEE Marks	50

Course learning Objectives	
1.	Understand the basic concepts of research and its methodologies
2.	Identify and select the appropriate research/sampling design methods.
3.	CreatetheawarenessaboutIntellectualPropertyRightsfortheprotectionofinventions.

Required Knowledge of : Probability & Statistics.

Unit–I	5 Hours

Research Methodology: Introduction

Meaning, Objectives, types, Research Approaches. Significance of Research, Research Methods versus Methodology, Research and scientific method, research Process, Criteria of good research, Problems encountered by researchers.

Research Problem:

Defining a research problem, Selecting a research problem, necessity and techniques involved in defining the research problem.

Unit–II	5Hours

Data Collection Methods:

Collection of Primary Data, Observation Method, Interview Method, Questionnaires, Schedules, Other Methods of Data Collection, Collection of Secondary Data, Case study method.

Processing and Analysis of Data

Processing operations, Elements/ types of analysis, Statistics in research- measures of central tendency or statistical averages, measures of dispersion, measures of asymmetry (skewness), measures of relationship, Simple regression analysis

Unit–III	5 Hours

Intellectual Property Rights – IPR- Invention and Creativity- Intellectual Property- Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures. Research ethics, Plagiarism, Priorart search.

Flipped Classroom Details

Unit No.	I	II	III
No. for Flipped Classroom Sessions	1	1	1

Self-Study Topics	
Unit No.	**Topic description**
I	Significance of Research Methodology.
II	Limitations of test of hypothesis.
III	Other measures-Index numbers, Time series analysis.

Books	
	Text Books:
1.	C R. Kothari, Research Methodology, New Age International Publishers, 2nd edition, 2007.
	Reference Books:
1.	PanneerSelvam, Research Methodology, PHI Learning Pvt. Ltd., 2007.
2.	Dr. B.L. Wadhera -Intellectual Property Rights, Universal Law Publishing Co. Ltd.. 2002
	William G Zikmund, Business Research Methods, Indian edition, South western Publishers, 8th Indian Reprint – 2009.
	E-resourses (NPTEL/SWAYAM. Any Other)- mention links
1.	https://onlinecourses.swayam2.ac.in/cec20_ge37 (Research Methodology)

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Research Activity
3.	Flipped Classes	3.	Semester End Examination

Course Outcome (COs)

Learning Levels:
Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Identify and select an appropriate methodology for research.	Un	1,2,9,10	1
2.	Analyze and interpret data collected	Ap	1,2,9,10	1
3.	Discuss the significance of Intellectual Property Rights & report writing	Ap	1,2,3,9,10	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Research Activity	Total Marks
Marks	20+20=40	10	50

IAs and Assignments: Minimum score to be eligible for SEE: 20 OUT OF 50

The weightage of Continuous Internal Evaluation (CIE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50).

Scheme of Semester End Examination (SEE):	
1.	The pattern of the **question paper is MCQ** (multiple-choice questions). The time allotted for SEE is **01 hour.**
2.	SEE paper shall be set for **50 questions, each of the 01 mark**.
3.	The weightage for Semester End Exam (SEE) is 50%. The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50).
4.	A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to the subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination)taken together.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓							✓	✓			✓		
2	✓	✓							✓	✓			✓		
3	✓	✓	✓						✓	✓			✓	✓	✓
Tick mark the CO, PO and PSO mapping															

EMPLOYABILITY SKILLS - I

Course Code	21AECEE58	Course type	AEC	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 20 Hrs; T = 0 Hrs; P = 0 Hrs Total = 20 Hrs			CIE Marks	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Pre-requisites :

Unit – I	Contact Hours = 4 Hours
General Aptitude 1.1: **Understanding Quantitative Aptitude : Number System, Averages, Ratio and Proportion Partnership**	

Unit – II	Contact Hours = 4 Hours
:General Aptitude 1.2: **Understanding Quantitative Aptitude : Percentages, Profit and Loss , Time and Work, Ages**	

Unit – III	Contact Hours = 4 Hours
General Aptitude 1.3: **Understanding Quantitative Aptitude : Number and Letter Series, Coding and Decoding and DST, Analogy and Blood Relations**	

Unit – IV	Contact Hours = 4 Hours
General Aptitude 1.4: **Understanding Quantitative Aptitude : Reading Comprehension, Sentence Correction, Ordering of Sentences**	

Unit – V	Contact Hours = 4 Hours
Improve Sense of Belongingness: Body Language, Grooming and Etiquette, Group Discussions	

Books	
	Text Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	The Aptitude Triad , BIZOTIC
	Reference Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
		3	Internal Assessments

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10	
2.	Perform confidently during the Interview process	L2	12	
3.	Develop Resumes that are grammatically correct	L2	10	
4.	Develop behaviors that are appropriate for a professional	L2	12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	10	15+15 =30	10	100
> Writing 2 IA tests is compulsory **> Minimum score to be eligible for SEE: 40 OUT OF 100**					

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										✓		✓			
2										✓		✓			
3										✓		✓			
4										✓		✓			
5										✓		✓			
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Logical Thinking**	**IT Industry**	**Software Engineer**
2	**Problem Solving**	**Automotive**	**Developer**
3	**Communication Skills**	**Education Sector**	**Project Manager**

ENVIRONMENTAL STUDIES

Course Code	21EE59A	Course type	HSMS	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 1Hrs; T = 0 Hrs; P =0 Hrs Total = 20 Hrs			CIE Marks	50
Flipped Classes content	10 Hours			SEE Marks	50

Course learning objectives	
1.	To understand the scope of Environmental Engineering.
2.	Identify the Environmental impact due to Human activities.
3.	To understand the concept of Disaster Management.
4.	Identify the renewable and non renewable sources of energy.
5.	Identify the various Legal aspects in Environmental Protection.

Pre-requisites:--

Unit – I	Contact Hours = 4 Hours
Definition of Environment, Ecology and Ecosystem, Structure and functions of ecosystem, balanced ecosystem, Introduction to Environmental Impact Assessment Natural Resources: Material Cycles - Oxygen, Carbon, Nitrogen and Hydrological cycle. Importance of water quality, Water borne diseases, Water induced diseases, Significance of Fluoride in drinking water	

Unit – II	Contact Hours = 4 Hours
Energy - Different types of energy, Conventional and Non - Conventional sources – Advantages and Limitations of Wind Mills, Hydro Electric, Fossil fuel, Nuclear, Solar, Biomass and Biogas, Geothermal energy	

Unit – III	Contact Hours =4 Hours
Disasters - Natural Disasters: Meaning and nature of natural disasters, their types and effects (Floods, drought, cyclone, earthquakes, Tsunami). Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution and marine pollution	

Unit – IV	Contact Hours = 4 Hours
Disaster Management: International strategy for disaster reduction. Concept of disaster management and national disaster management framework	

Unit – V	Contact Hours = 4 Hours
Environmental Protection: Role of Government, Legal aspects, Initiatives by Non - Governmental Organizations (NGO), Environmental Education, Women Education. E waste and solid waste management rules	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Benny Joseph, **"Environmental Studies",** Tata McGraw - Hill Publishing Company Limited (2005).
2.	Ranjit Daniels R.J. and JagdishKirshnaswamy, **"Environmental Studies",** Wiley India Private Ltd., New Delhi (2009).
3.	Sanjay K. Sharma, **"Environment Engineering and Disaster Management",** USP (2011).
4.	Harsh K. Gupta, **"Disaster Management",** Universities Press (India) Pvt. Ltd (2003).
	Reference Books:
1.	Meenakshi P., **"Elements of Environmental Science and Engineering",** Prentice Hall of India Private Limited, New Delhi (2006).
2.	Tyler Miller Jr. G., **"Environmental Science – Working with the Earth",** Tenth Edition, Thomson Brooks/Cole (2004).
	E-resources (NPTEL/SWAYAM/Any Other)- mention links
1.	–

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcomes(COs)				
At the end of the course, the student will be able to:		Learning Level	PO(s)	PSO(s)
1.	Explain the importance of the Environment	Un	1,6,7	1
2.	Evaluate Environmental disasters caused by human activities	Un	1,6,7	1
3.	Outline the water problems and energy crisis in the present era	Un	1,6,7	1
4.	Explain and classify the Renewable and Non-Renewable sources of energy	Un	1,6,7	1
5.	Summarize the various Legislations related to Environment	Un	1,6,7	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two Assignments	Total Marks
Marks	15+15 = 30	10+10 =20	50
Writing the IA test is Compulsory **Minimum marks required to be eligible for SEE: 20 out of 50**			

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 50 marks of 1 hour duration.
2.	**Minimum marks required in SEE to pass: 20 out of 50**
3.	Question paper contains multiple choice questions.

CO-PO Mapping (Planned) [tick mark relevant ones]													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✔					✔	✔						✔		
2	✔					✔	✔						✔		
3	✔					✔	✔						✔		
4	✔					✔	✔						✔		

Communicative English

Course Code:	21EE59B	Course type	MNC	Credits L-T-P	1– 0- 0
Hours/week: L-T-P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 15 Hrs, T = 0 HrsP = 0 Hrs Total = 15 Hrs			CIE Marks	50
Flipped Classes content	3Hours			SEE Marks	Nil

Course learning objectives	
1.	Enhance pronunciation and fluency for better communication skills.
2.	Augment English vocabulary and grammar for better communication skills.
3.	Impart basic language skills [LSRW].
4.	Achieve better writing skills for employment.
5.	Understand the importance of Non-verbal communication

Pre-requisites: Conversant with basic English Grammar and able to understand spoken English.

Unit – I Introduction to Listening Skills	Contact Hours = 2 Hours
Content of the Unit: Introduction to Listening Comprehension, Hearing and Listening, Listening Process, Types of Listening, Barriers of Listening, Effective and Passive Listening, Reasons and Disadvantages of Poor Listening.	

Unit – II Introduction to Speaking Skills	Contact Hours = 3 Hours
Content of the Unit: Introduction to Phonetics of English Vowel and Consonant sounds, Phonetic Transcription [IPA/RP], English Syllables, Rules for Word Accent -Stress Shift, Intonation, Silent and Non-silent Letters.	

Unit – III Introduction to Reading Skills	Contact Hours =2 Hours
Content of the Unit: Reading Meaning and Stages, Importance of Reading, Types of Reading, Characteristics of Reading, Process of Reading, Approaches and Factors Influencing Reading, Techniques or Strategies of Reading.	

Unit – IV Introduction to Writing Skills	Contact Hours = 3 Hours
Content of the Unit: Introduction Writing Paragraphs, Parts of the paragraph, Importance of Proper Punctuation, Creating Coherence and Cohesion in Writing, Precise writing, Importance of Summarizing and Paraphrasing. Types of Writing,	

Unit –V Introduction to Non- Verbal communication	Contact Hours = 2 Hours
Content of the Unit: Introduction to Nonverbal Communication, Importance of NVC, Types of NVC- Gestures, Postures, Haptics, Proxemics, Chronemics and Paralanguage.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	**	Grammar-I	**	Grammar-II	Grammar III

	Books
	Text Books:
1.	A Textbook of English Language Communication Skills, Infinite Learning Solutions– (Revised Edition) 2021.
	Reference Books:
1.	Communication Skills by Sanjay Kumar and Pushp Lata, Oxford University Press - 2019.
2.	English for Engineers by N.P.Sudharshana and C.Savitha, Cambridge University Press – 2018.
	E-resources (NPTEL/SWAYAM. Any Other)- mention links
1.	Technical English for Engineers course Swayam/ NPTEL https://onlinecourses.nptel.ac.in/noc22_hs34/preview
2.	ESOL Courses: Listening & Grammar free online video lesson https://www.esolcourses.com/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	CIE assignments
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Course seminar
4.	Online classes, if required.	4.	

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	To understand and identify the Common Errors in Writing and Speaking.	Re		
2.	2. To Achieve better technical writing and Presentation skills.	Un		
3.	3. To read technical proposals properly and make them Write good technical reports.	Ap		
4.	4. Acquire Employment and Workplace communication skills.	An		

Scheme of Continuous Internal Evaluation (CIE):

Components	Assignments	Course Seminar	Quizzes	Total Marks
Marks	10+10= 20	10	10x2=20	50

Scheme of Semester End Examination (SEE): No SEE component	
1.	NA
2.	**Minimum marks required in SEE : NA**
3.	The weightage of Continuous Internal Evaluation (CIE) is 100%

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										√					
2										√					
3										√					
4										√					
5										√					
Tick mark the CO, PO and PSO mapping															

6TH SEMESTER

Industrial Management, Electrical Estimation & Costing

Course Code	21EE61	Course type	HSMS	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the Characteristics of management, role of management, importance and purpose of planning, organizing, staffing, directing and controlling.
2.	Understand the meaning of innovation, creativity, entrepreneur, entrepreneurship, Creative Problem Solving techniques.
3.	Demonstrate an understanding of basic concepts in estimation and costing, earthing, Indian Electricity Act and major applicable I.E rules, estimation and costing of residential wiring.

Pre-requisites : Basic Electrical Engineering

Unit – I	Contact Hours = 8 Hours
Management: Introduction, nature and characteristics of Management, Scope and Functional areas of management **Planning:** Nature, importance and purpose of planning process, Types of plans, Decision making, Importance of planning, steps in planning, case studies. **Organizing**: Nature and purpose of organization, Principles of organization, Types of organization, Span of control, case studies.	

Unit – II	Contact Hours = 8 Hours
Staffing, Directing & Controlling: Nature and importance of staffing, Process of Selection & Recruitment, Training Methods, case studies. **Directing**: Meaning and nature of directing, Leadership styles, Motivation Theories, Communication-Meaning and importance, case studies. **Controlling:** Meaning and steps in controlling, Essentials of a good control system, Methods of establishing control, case studies.	

Unit – III	Contact Hours = 8 Hours
Entrepreneur: Meaning of entrepreneur: Evolution of the concept: Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Stages in entrepreneurial process. **Creativity and Innovation**: Creativity, Source of New Idea, Ideas into Opportunities, Creative Problem Solving: Heuristics, Brainstorming, Synectics, and Significance of Intellectual Property Rights.	

Unit – IV	Contact Hours = 8 Hours
Introduction to estimation & costing: electrical schedule, catalogues, market survey and source selection, determination of required quantity of material, labour conditions, determination of cost material and labour ,contingencies, overhead charges, recording of estimates, profit, purchase system, statement, purchase orders. **I.E. Rules:** General idea about IE rules, Indian electricity act and major applicable I.E rules.	

Unit – V	Contact Hours = 8 Hours
Residential & Commercial Wiring System: General rules guidelines for wiring of residential installation and positioning of equipment, principles of circuit design in lighting and power circuits, procedures for designing the circuits and deciding the number of circuits, method of drawing single line diagram, fundamental consideration for planning and design of electrical installation system for commercial buildings. **Selection & Calculation:** Selection of type of wiring and rating of wires and cables, load calculations and selection of size of conductor, selection of rating of main switch, distribution board. Earthing of residential installation, sequence to be followed for preparing estimate, preparation of detailed estimates and costing of residential installation, illustrative examples of residential building wiring, estimation and costing, preparation of detailed estimate and costing of commercial installation.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	02	02	02	02	02

Books	
	Text Books:
1.	Harold Koontz : "Essentials of Management", McGraw Hill Series in Management, 6th Edition.
2.	Poornima.M.Charantimath : Entrepreneurship Development – Pearson Education – 2014 Edition
3.	J.B.Gupta, "Electrical Installation Estimating & Costing" VIII Edition S.K. Katria& Sons New Delhi
	Reference Books:
1.	N V R Naidu, "Management & Entrepreneurship"- IK International, 2008
2.	P.C.Tripathi, P.N.Reddy "Principles of Management" — Tata McGraw Hill.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/110105146/
2.	https://archive.nptel.ac.in/courses/110/107/110107150/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1									✓	✓		✓				✓
2									✓	✓		✓				✓
3	✓	✓									✓	✓		✓		
Tick mark the CO, PO and PSO mapping																

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the scope and **apply** the concepts of management.	Un, An	9,10,12	4
2.	**Explain** the characteristics and process of entrepreneurship.	Un	9,10,12	4
3.	**Design** and **estimation** of wiring and lighting scheme for residential application.	Ap	1,2,11, 12	2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass**: Score should be > 35%, however overall score of CIE + SEE should be > 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Managerial Skills, Entrepreneurship skills**	**Manufacturing Industries, Service Industries**	**Entrepreneurs, HR Manager, Team Leader**

Control Systems

Course Code	21EE62	Course type	PCC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To demonstrate an understanding of basic concepts of control systems, their types & requirements. Identify controllers, their types, features & applications. To formulate, construct and explain models of physical systems in terms of differential equations, transfer functions,
2.	To understand block diagrams, signal flow graph, explain and analyze performance of Feedback Control systems in terms of Time domain specifications.
3.	To understand and explain the concept of Absolute and relative Stability of Feedback control systems using R-H criterion, Root locus technique
4.	To understand and explain the concept of Absolute and relative Stability in Frequency domain analysis methods such as Polar plots and Bodes plots.
5	To understand and explain the concept of compensation techniques and PID controllers in feedback control systems, types of compensators and their applications

Pre-requisites : Differential Equations & Laplace transforms , Basic Electrical Engineering

Unit – I	**Contact Hours = 8 Hours**
Modeling of Systems: Introduction to control systems, classification of control systems, open loop and closed loop control systems with examples. Differential equations of physical systems – mechanical systems- friction, translational systems rotational systems, gear trains, electrical systems, analogous systems	

Unit – II	**Contact Hours = 8 Hours**
Block diagrams and signal flow graphs: Transfer functions, block diagrams, signal flow graphs. **Time Response of feedback control systems**: Standard test signals, unit step response of first and second order systems, time response specifications (no derivations).Time response specifications of second order systems, steady – state errors and error constants.	

Unit – III	Contact Hours = 8 Hours
Stability analysis: Concepts of stability, necessary conditions for Stability, Routh-Hurwitz stability criterion, relative stability analysis; special cases of RH criterion. **Root–Locus Techniques**: Introduction, basic properties of root loci, construction of root loci. Introduction to MATLAB.	

Unit – IV	Contact Hours = 8 Hours
Frequency domain Analysis: Introduction, advantages of frequency domain analysis. Correlation between time and frequency domain specifications. Polar plots, definitions of gain margin, and phase margin. **Frequency domain analysis:** Bode plots, assessment of stability from Bode plot.	

Unit – V	Contact Hours = 8 Hours
Compensators: Design of lead, lag, lag lead compensators and applications. **Controllers:** Proportional, Proportional derivative, proportional integral and PID controller, advantages and disadvantages of each controller.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	R Ananda Natarajan, P Ramesh Babu **Control System Engineering,**2006 Scitech Publications (India) PVT Ltd.
2.	D Ganesh Rao, K Channa Venkatesh, **Control Engineering,** , Sanguine Technical Publishers 2005, Revised edition.
	Reference Books:
1.	I. J. Nagarath and M.Gopal,**Control Systems Engineering,** New Age International (P) Limited, 4th, Edition – 2005
2.	Norman S Nise, **Control Systems Engineering**, ,Wiley Student Edition,5th Edition,2009
	E-resources (NPTEL-links)
1.	https://nptel.ac.in/courses/108106098
2.	https://nptel.ac.in/courses/108106150

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	*Define* control system. *Classify* the control system and Understand the modeling of physical systems.	Re, Ap	1,12	1,2
2.	*Apply* the block diagrams and signal flow graph simplification techniques to reduce the system into single and *evaluate* the transfer function. Determine the time response of a typical second order system for step input.	Ap, Ev	1	1,2
3.	*Explain* and *illustrate* the Root locus and Routh Hurwitz technique to assess the stability of closed loop systems.	Un, Ev	1,2,5	1,2
4.	*Explain* and compare the frequency domain analysis with time domain analysis. *Construct* the polar and Bode plot to *assess* stability of the given system.	Un, Ap, Ev	1,2,5	1,2
5.	*Define Compensators and controllers. Analyze* the performance of system response with compensators and controllers.	Re, An	1	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔									✔		✔	✔	✔		
2	✔									✔		✔	✔	✔		
3	✔	✔			✔					✔			✔	✔		
4	✔	✔			✔					✔			✔	✔		
5	✔									✔			✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Modeling physical systems, assess performance & stability	Automation & Control process	Maintenance, Control and Automation Engineer

Computer Techniques in Power System Analysis

Course Code	21EE63	Course type	PCC	Credits L-T-P	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Explain the basic principles of matrix algebra, elementary graph theory and primitive network, network matrices
2.	Explain and develop the power flow equations, classify different types of buses and compare different methods of load flow analysis.
3.	Explain the economic generation scheduling & transmission losses
4.	Formulate bus impedance matrix to apply for short circuit studies and explain the solution of swing equation using numerical methods.
5.	Explain & Develop source codes in MATLAB for simulating various power system problems & analyze
6.	To perform fault analysis, load flow studies, economic load dispatch using power system simulation software package.

Required Knowledge of : Matrix algebra, power system analysis, Numerical techniques

Unit – I: Network Topology	**Contact Hours = 8 Hours**
Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop analysis. Formation of Incidence Matrices. Primitive network- Impedance form and admittance form, Formation of Y Bus by Singular Transformation, Y bus by Inspection Method, Illustrative examples.	

Unit – II: Load Flow Studies I	**Contact Hours = 8 Hours**
Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples.	

Unit – III: Load Flow Studies II	**Contact Hours = 8 Hours**
Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods. Illustrative examples	

Unit – IV: Economic Operation of Power System	Contact Hours = 8 Hours
Introduction and Performance curves, Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses, Derivation of transmission loss formula, Illustrative examples. Unit Commitment: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flowchart and Algorithm only)	

Unit –V: Symmetrical Fault Analysis & Stability	Contact Hours = 8 Hours
Z Bus Formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples. Z bus Algorithm for Short Circuit Studies excluding numerical. **Power System Stability**: Numerical Solution of Swing Equation by Point by Point method and Runge Kutta Method. Illustrative examples	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	2	Ybus Formations, Line flows and power flows
2	1	Load flow studies using GS method
3	1	Load flow studies using NR method/Jacobian Formation
4	1	Optimal Generator Scheduling
5	2	Fault studies, Zbus formation

Books	
	Text Books:
1.	Stag, G. W., and EI-Abiad, A. H., **"Computer Methods in Power System Analysis",** McGraw Hill, International Student Edition.
2.	Pai, M. A , **"Computer Techniques in Power System Analysis",** TMH, 2nd edition
3.	K.Uma Rao, **"Computer Techniques and models in power systems",** I.K. International Publications.
	Reference Books:
1.	Nagrath, I. J., and Kothari, D. P, **"Modern Power System Analysis",** TMH, 3rd Edition.
2.	Dhar, R. N, **"Computer Aided Power System Operations and Analysis",** TMH.
	E-resources :
1.	https://onlinecourses.nptel.ac.in/noc19_ee62/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO (s)
1.	**Explain & Apply** the concept of Network Topology and primitive network, network matrix Ybus	Re, Ap	1,2,12	1,2
2.	**Develop** the load flow solutions using different Numerical techniques	Ap	1,2	1,2
3.	**Estimate** optimal scheduling of generators and **explain** the unit commitment.	Ev, Un	1,2	1,2
4.	**Apply** Zbus for short circuit studies and **make use of** Numerical methods for solving swing equation.	Ap	1,2	1,2
5.	**Develop Programs** in MATLAB and make use of simulation software for Power System studies.	Ap	1,2,5,9, 10,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)/ Course project	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batch wise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping(planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔	✔										✔	✔	✔		
2	✔	✔											✔	✔		
3	✔	✔											✔	✔		
4	✔	✔											✔	✔		
5	✔	✔			✔							✔	✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Formation of power system matrix using the data, usage of numerical techniques for power system analysis, Programming, Power System Simulation	Power Systems-Grids, Transmission Lines, Distribution Systems, Core Industries	Power System- Design, maintenance and control Engineer, Consultants and commissioning entrepreneurs.

Power System Protection & High Voltage Engineering

Course Code	21EE64	Course type	PCC	Credits L-T-P	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the fundamentals of protective systems and relays.
2.	To demonstrate an understanding of the basic principle of circuit breaking operation and various types of CB's
3.	Understand the electric breakdown phenomenon in solid, liquid, and gaseous insulating mediums.
4.	Understand the various methods of generation of HVAC, HVDC, Impulse voltage and current.

Required Knowledge of : Fuse, CT, PT

Unit – I	Contact Hours = 8 Hours
Protective Relaying: - Requirements of protective relaying, Zones of Protections, Essential qualities of protective Relaying, Classification of Protective Relays, Discrimination. Relays:- Directional over current relay, Impedance relay, Reactance relay, Negative sequence relay, static relay, Numerical relay.	

Unit – II	Contact Hours = 8 Hours
Principle of AC Circuit breaking: Arc, Arc initiation, Arc interruption, Arc interruption theories- Slepian's theory and Energy balance theory, re striking voltage, recovery voltage, Rate of rise of Re- striking voltage, Current chopping, Resistance switching. **Circuit breakers**: SF6 circuit breaker, Vacuum circuit breaker.	

Unit – III	Contact Hours = 8 Hours
Introduction to HV Engineering: Generation of high voltages, Classification of HV insulating media, Properties of important HV insulating media under each category. **Breakdown in gases:** Gaseous dielectrics, Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory, Limitations of Townsend's theory. Streamer's theory of breakdown in non-uniform fields. Corona discharges, Breakdown in electro negative gases, Paschen's law and its significance, Time lags of Breakdown.	

Unit – IV	Contact Hours = 8 Hours
Breakdown in solids & liquids: Breakdown in solid dielectrics: Intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanic breakdown. breakdown of liquid dielectrics: suspended particle theory, electronic Breakdown, cavity breakdown (bubble's theory),	

Unit – V	Contact Hours = 8 Hours
Generation of HVAC, HVDC, impulse voltage and current: HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade, series resonant circuit- principle of operation and advantages, Tesla coil, HV DC- voltage doubler circuit, cock croft- Walton type high voltage DC set, calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop. (No derivation) Introduction to standard lightning and switching impulse voltages, expression of single stage impulse generator- for Output impulse voltage, multistage impulse generator working of Marx circuit, components of multistage impulse generator, Trigatron gap.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**5**	**Over Current relay, static relay, Numerical relay, fuse, negative sequence relay**
2	**1**	**Measurement of breakdown strength of air**
4	**1**	**Breakdown strength of oil**
5	**2**	**Generation and measurement of HVAC and HVDC**

Unit No.	Self-Study Topics
1	**Fuse characteristics, Construction and working of CT, PT**
3	**Various types of Dielectric materials**

	Books
	Text Books:
1.	Sunil S Rao, "Switchgear and protection " Khanna Publishers
2.	Badri Ram and Vishwakharma, " Power System Protection and Switchgear" TMH
3.	M.S.Naidu and Kamaraju, **"High Voltage Engineering"**, 4th Edition onwards, TMH.
4.	C.L.Wadhwa, **"High Voltage Engineering"**, New Age International Private limited.
	Reference Books:
1.	Soni Gupta Bhatnagar, "A course in Electrical Power", Dhanapatrai Publications
2.	E.Kuffel and W.S. Zaengl, **"High Voltage Engineering Fundamentals"**, 2nd Edition, Elsevier Press.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108105167
2.	https://nptel.ac.in/courses/108107167

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)				
Learning Levels: **Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create**				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the basic principle of protective relaying and understanding the working of different types of relays.	Un	1,12	1,2
2.	**Explain** the various circuit breaker concepts and types of circuit breakers	Un	1,12	1,2
3.	**Describe** the various breakdown phenomenon in gases , solid, and liquid insulating medium.	Ap	1,12	1,2
4.	**Explain** and **analyze** the generation of HVAC, HVDC and impulse voltage and current.	Ap	1,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)/ Course project	Conduction	Lab test	Total
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batch wise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping (planned)			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔				✔					✔		✔	✔	✔		
2	✔									✔		✔	✔	✔		
3	✔									✔		✔	✔	✔		
4	✔									✔		✔	✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Planning & Implementing of adequate protection schemes with suitable switchgear, handling HV equipments	Power System Protection in Electric power systems, industrial power systems, high voltage industrial sectors	Power System Protection Engineer, HV Engineer.

Field Theory

Course Code	21EEPE651	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
2.	To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
3.	To evaluate the energy and potential due to a system of charges.
4.	To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
5.	To study the magnetic fields, propagation of waves and magnetic materials.

Unit – I	Contact Hours = 8 Hours

Vector Analysis: Scalars and Vectors, Vector algebra, Cartesian co-ordinate system, Vector Components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field, Co – ordinate systems: cylindrical and spherical, relation between different coordinate systems. Expression for gradient, divergence and curl in rectangular, cylindrical and spherical co-ordinate systems, Numerical.

Electrostatics: Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications, Maxwell's first equation (Electrostatics), Divergence theorem, Numerical.

Unit – II	Contact Hours = 8 Hours

Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient, The dipole, Energy density in the electrostatic field. Numerical.

Conductor and Dielectrics: Current and current density. Continuity of current. Metallic conductors, conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates, Numerical.

Unit – III	Contact Hours = 8 Hours
Poisson's and Laplace Equations: Derivations and problems, Uniqueness theorem. **Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law, The Curl. Stokes theorem, Magnetic flux and flux density, Scalar and vector magnetic potentials, Numerical.	

Unit – IV	Contact Hours = 8 Hours
Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Numerical. **Magnetic Materials and Magnetism:** Nature of magnetic materials, magnetization and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Numerical.	

Unit – V	Contact Hours = 8 Hours
Time Varying Fields and Maxwell's Equations: Faraday's law, Displacement current, Maxwell's equations in point form and integral form. Numerical. **Uniform plane wave:** Wave propagation in free space and in dielectrics, Pointing vector and power considerations. Propagation in good conductors, skin effect, Numerical.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Engineering Electromagnetics, William H Hayt et al, McGraw Hill, 8th Edition, 2014.
2.	Principles of Electromagnetics, Matthew N. O. Sadiku, Oxford, 6th Edition, 2015.
	Reference Books:
1.	Fundamentals of Engineering Electromagnetics, David K. Cheng, Pearson, 2014.
2.	Electromagnetic Field Theory, RohitKhurana, Vikas Publishing, 1st Edition,2014.
	E-resources
1.	https://onlinecourses.nptel.ac.in/noc23_ee97/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain different coordinate systems for understanding the concept of gradient, divergence and curl of a vector and Coulombs Law and Gauss Law.	Re, un	1,2	1,2
2.	Analyze the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics and of magnetic fields and magnetic materials	Un, An	1,2,12	1,2
3.	To Analyze the time varying fields and propagation of waves in different media	Un, An	1,2	1,2
4.	Determine the energy and potential due to a system of charges.	Un, Ap	1,2,12	1,2
5.	To apply the theory of magnetic fields and magnetic materials.	Re, Un,	1,2	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B& C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔	✔											✔	✔		
2	✔	✔										✔	✔	✔		
3	✔	✔											✔	✔		
4	✔	✔										✔	✔	✔		
5.	✔	✔											✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Electromagnetic Field Theory	Electricity Supply Industries	HV Engineer Material Engineer

ADVANCED POWER ELECTRONICS

Course Code	21EEPE652	Course type	PEC	Credits L-T-P	3 - 0 - 0
Hours/week: L - T- P	3 - 0 - 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Analyze the operation of different types of switched mode dc-dc converters operating in different modes and design of dc-dc converters for different modes of operation.
2.	Analyze the operation of dc-dc converters with isolation for power supply applications.
3.	Demonstrate an understanding of principles of high frequency inductor and transformer design.
4.	Explain the operation of resonant converters.
5.	Analyze application of power electronics to battery management systems.

Required Knowledge of: Power Electronics.

Unit – I	Contact Hours = 8 Hours
Introduction to switched mode DC-DC converters: Introduction, topologies, Buck and boost DC-DC converter-detailed theory, working principles, analysis in CCM and DCM modes, boundary between continuous and discontinuous conduction, output voltage ripple, examples, applications, merits and demerits.	

Unit – II	Contact Hours = 8 Hours
Switched mode DC-DC converters (continued): Buck-boost converter-detailed theory, working principles, CCM and DCM modes analysis, boundary between continuous and discontinuous conduction, output voltage ripple, Cuk converter- detailed theory, examples, applications, merits and demerits. **Switched Mode DC Power Supplies:** Introduction, Linear power supplies, overview of switching power supplies: fly back converter - circuit operation and analysis, examples.	

Unit – III	Contact Hours = 8 Hours
Switched Mode DC Power Supplies (continued): Forward converter, push-pull converter, half bridge converter, full bridge converter- circuit operation and analysis, examples, applications, merits and demerits. **AC power supplies:** Switched mode AC power supply, resonant AC power supply, bidirectional AC power supplies.	

Unit – IV	Contact Hours = 8 Hours
High Frequency Inductor And Transformers: design principles, single pass inductor design procedure (with flow chart), and Single pass Transformer design procedure (with flow chart). **Resonant Converters**: Principle of Zero voltage and zero current switching, comparison with hard switching, ZVS and ZCS resonant switch converters operation (detailed analysis excluded) (clamped voltage topologies excluded)	

Unit – V	Contact Hours = 8 Hours
Power Electronics In Battery Management Systems: Application of power electronics in rechargeable batteries, battery charge management, cell balancing, SOA of battery.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Ned Mohan, Tore M. Undeland, and William P. Robins, **"Power Electronics – Converters, Applications and Design",** Third Edition, John Wiley and Sons.
2.	Daniel.W.Hart, **"Power Electronics"**, TMH, First Edition.
3.	Hua Bai, Chris Mi, "Transients of Modern Power Electronics", John Wiley & Sons Ltd, first edition.
4.	M.H.Rashid, **"Power Electronics",** Pearson, 3rd Edition.
	Reference Books:
1.	L. Umanand, **"Power Electronics Essentials and Applications"**, Wiley India Pvt. Ltd.
2.	V.R.Moorthi, **"Power Electronics, Devices, Circuits and Industrial Applications"**, Oxford,7th impression.
3.	Muhammad Rashid, **"Digital Power Electronics and Applications",** Elsevier , first edition.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108108036

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests
4.	Online classes	4.	Course seminar
		5.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO (s)
1.	**Analyze** the operation of different types of switched mode dc-dc converters in CCM and DCM modes and design the circuit parameters.	An	1, 2, 10,12	1,3
2.	**Analyze** the operation of different types of dc-dc converters for power supply applications and determine the circuit parameters.	An	1, 2, 4, 10, 12	1,3
3.	**Explain** high frequency inductor and transformer design for PE systems.	Un	1, 12	1,3
4.	**Explain** principle of ZVS and ZCS switching for converters.	Un	1, 12	1,3
5.	**Analyze** the role of power electronics in battery management systems.	An	1, 4, 9, 10, 12	1,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓								✓		✓	✓		✓
2	✓	✓		✓						✓		✓	✓		✓
3	✓												✓		✓
4	✓												✓		✓
5	✓			✓					✓	✓		✓	✓		✓
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	Design of SMPS converters for power management applications	1. Battery chargers for EV 2. SMPS manufacturing industries & sales sector	1. Power Electronic Engineer/Design Engineer 2. System engineer (Power electronics)
2	Knowledge of BMS & control	Battery industries	1. Battery design engineer 2. System engineer for BMS

Signals, Systems & Processing

Course Code	21EEPE653	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To demonstrate an understanding of the definition, classification of the signals, properties of systems and their response.
2.	Learn the conceptand applications of Z transform and Discrete Fourier Transform tools.
3.	To demonstrate and understand the realization of digital systems, block diagrams realization of IIR systems and FIR systems of different forms.
4.	Get acquainted withConcept and applications Fast Fourier transforms algorithms.
5.	Understand and interpret theapplications and design of IIR and FIR filters.

Pre-requisites: Calculus, Laplace Transformation, Z transforms.

Unit – I	Contact Hours = 8 Hours

Basic of Signals and Systems: Definition of signals and a system, classification of signals and types. Basic operations on signals-Amplitude scaling, addition, multiplication, time shifting, time scaling. Properties of systems.

Linear Time Invariant Systems- Impulse response and system properties using Impulse response, Convolution sum, Convolution integral.

Unit – II	Contact Hours = 8 Hours

Z- Transform-Introduction, properties of Region of Convergence (ROC), properties of Z-transforms, Z transform problem, inverse Z-transform by partial fraction expansion method, System Transfer function, System stability and causality.

Self learning topics: Z-transform by partial fraction expansion method.

Unit – III	Contact Hours = 8 Hours
Discrete Fourier Transforms: Definitions, properties-Periodicity, circular time shift, circular frequency shift, circular folding, and multiplication in time domain. **Realization of digital systems:** Introduction, block diagrams, realization of IIR systems-direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form.	

Unit – IV	Contact Hours = 8 Hours
FFT and Algorithms: Introduction, decimation in time algorithm, first decomposition, continuation of decomposition, number of multiplications, and decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms. **Fast convolution techniques** - overlap add and overlap save methods.	

Unit –V	Contact Hours = 8 Hours
Design of IIR digital filters: Introduction, bilinear transformations, design of analog filters- Butterworth filter & Chebyshev filter. **Introduction to FIR digital filters:** Design of linear FIR filter using rectangular window, Hanning window, Hamming window with an example.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Signals and Systems- Simon Haykin and Barry Van Veen, John Wiley & Sons Publishers
2.	Digital Signal Processing Principle, Algorithm & application, John G Proakis, Dimitris G. Manolakis, Pearson Publishers.
3.	Signals and Systems, Udaykumar S, Elite Publishers, Fourth edition-2005 Mangalore.

	Reference Books:
1.	Signals and Systems, Alan V Oppenheim, Alan S. Willsky and S. Hamid Nawab,PHI Publishers.
2.	Signals and Systems, H P Hsu and others, Schaums Outline Series, TMH Publishers.
3.	Introduction To Digital Signal Processing, Johnny R. Johnson, PHI Publishers.
4.	Fundamentals of Signals and Systems - Michel J Roberts, TMH Publishers.
5.	Digital Signal Processing, Sanjeet. K. Mitra, TMH Publishers.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/117102060
2.	https://archive.nptel.ac.in/courses/108/104/108104100

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the definition, types and properties of Systems and Signals and response of systems and their properties	Un	1,2	3
2.	**Explain** and **apply** Z transform and Discrete Fourier transform tools	App	2,4,12	3
3.	**Explain** and **apply** Realization of Digital systems, block diagrams and SFGs, realization of IIR systems and FIR systems of different forms.	App	2,4,12	3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1		✔							✔	✔					✔
2		✔		✔					✔	✔		✔			✔
3		✔		✔					✔	✔		✔			✔
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	This course equips students with a strong foundation in analyzing signals, modeling systems, and applying mathematical techniques. These skills enhance students problem-solving abilities and analytical thinking	Telecommunications, Biomedical Engineering, Electrical Power Systems, Defense and Aerospace, Robotics and Automation, Research and Development etc	Signal Processing Engineer, Communications Engineer, Biomedical Engineer, Robotics Engineer, Research Scientist

ELECTRIC VEHICLES

Course Code	21EEPE654	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Demonstrate an understanding of the concept of electric vehicles.
2.	To study about the motors & drives for electric vehicles.
3.	To understand the electronics and sensors in electric vehicles.
4.	To understand the concept of hybrid vehicles.
5.	To study fuel cells for electric vehicles.

Pre-requisites : Basic electrical engineering

Unit – I: Introduction to Electric Vehicles	Contact Hours = 8 Hours
Electric Vehicle – Need - Types – Cost and Emission. **Electric Vehicle Technology** – layouts, cables, components, Controls. **Batteries** – overview and its types. Battery plug-in and life. Ultra-capacitor, **Charging** – Methods and Standards. Alternate charging sources – Wireless & Solar. Self study : History of electric vehicles	

Unit – II: Electric Vehicle Motors	Contact Hours = 8 Hours
Motors– Types (DC, Induction, BLDC), Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling, Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor Design. Self study : Planetary gear system.	

Unit – III: Electronics and Sensor-less control in EV	Contact Hours = 8 Hours
Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self-drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance- Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.	
Unit – IV: Hybrid Vehicles	**Contact Hours = 8 Hours**
Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV , Layout and Architecture – Series,Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction, Hybrid Electric Vehicles System – Analysis and its Types, Controls. Self study : Hydrogen fuelled transportation.	

Unit – V: Fuel Cells for Electric vehicles	Contact Hours = 8 Hours
Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance. Self study : other energy storage devices.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

TEXT BOOKS	
1	Jack Erjavec and Jeff Arias, “Hybrid, Electric and Fuel Cell Vehicles”, Cengage Learning, 2012.
2	Jack Erjavec and Jeff Arias, “Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles”, Cengage Learning Pvt. Ltd., New Delhi, 2007
3	Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2009.
REFERENCES	
1	Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2	Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.
3	Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
4	Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.
5	Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.
Online courses	
	https://onlinecourses.nptel.ac.in/noc23_ee01/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the working principle of electric vehicles.	Un	1,2,12	1
2.	Explain the construction and working principle of various motors used in electric vehicles.	Un	1,2,12	2
3.	Explain & utilize the working principle of electronics and sensor less control in electric vehicles.	Ap	1,2,12	2
4.	Classify the hybrid vehicles and their working principle.	Un	1,2,12	1
5.	Illustrate the various types and working principle of fuel cells.	Un	1,2	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔											✔	✔	✔		
2		✔										✔	✔	✔	✔	
3	✔											✔	✔			
4		✔												✔		
5			✔									✔			✔	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Classify electric vehicles, optimum choice of EVs, Design & fabrication of EVs	EV-Manufacturing & Transportation sector	EV Design & Maintenance Engineer, Sales Engineer

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS

Course Code	21EEPE655	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Discuss the performance parameters and specifications of various electrical equipment as per standards.
2.	Describe various tests on electrical equipments
3.	Discuss the methods of installation and maintenance procedures of various electrical equipments.

Pre-requisites: Transformers, Induction Machines, Synchronous Machines, Switchgear

Unit – I	Contact Hours = 8 Hours
Transformers: **Specifications:** Power and distribution transformers as per BIS standards. **Installation:** Location, Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Oil filtration unit, Drying of Windings.	

Unit – II	Contact Hours = 8 Hours
Commissioning Tests: As Per National and International Standards-Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests. **Maintenance:** Causes of troubles and failures in power transformer and preventive actions, maintenance of transformer, noise in the transformer.	

Unit – III	Contact Hours = 8 Hours
Synchronous Machines: **Specifications and Installation:** specifications as per BIS Standards, Installation-Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out. **Testing of Synchronous machines:** Measurement of Insulation resistance, Measurement of D.C. resistance of windings, No load saturation test, sudden three phase short circuit test on generator, negative phase sequence test, slip test and calculation of X_q and X_d.	

Unit – IV	Contact Hours = 8 Hours
Induction Motor: **Specification and Installation:** specification, Procurement, Duty, Installation of Induction motor (Foundation, shaft installation), Drying of windings. **Testing:** Insulation test, measurement of winding resistance, High voltage test: IS 4029, Load test, No load test, Temperature rise test, determination of efficiency, speed torque characteristics. **Maintenance:** Troubles, causes and remedies in Induction motor, protection of Induction motor, maintenance procedure for induction motor. **Self-learning topics:** Maintenance of induction motors	

Unit –V	Contact Hours = 8 Hours
Switchgear and Protective Devices: Types of Circuit Breakers, Specification of High Voltage circuit breaker. **Tests on Circuit Breaker:** Insulation resistance measurement, Impulse voltage test, short circuit testing station and short circuit test, HVDC circuit breaker, Maintenance of Circuit Breaker **Tests on CTs and PTs:** Specification of VTs, Errors in VTs, Specification of CT, Effect of secondary open circuit, procurement of CTs, Testing of CTs **Self-learning topics:** Maintenance of Circuit Breaker.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	S.Rao. "Testing, Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publishers, 6thEdition, 19thReprint, 2015.
2.	R.L.Chakrasali, "Testing and Commissioning of Electrical Equipment", Prism Books Pvt. Ltd.
3.	S.K.Sharotri, "Preventive Maintenance of Electrical Apparatus", Katson Publishing House, 1stEdition, 1980.
	Reference Books:
1.	"Handbook of Switchgears", BHEL, McGraw Hill, First Edition, 2005.
2.	"Transformers", BHEL, McGraw Hill, 1stEdition, 2003.
3.	Martin J. Heathcote, "The J&P Transformer Book", Newnes, 12thEdition, 1998.
4.	H.N.S. Gowda, "A handbook on operation and maintenance of transformers".

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - ✓Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Describe the standards in the process of planning and commissioning of electrical equipments.	Ap	1,12	1,2
2.	Specify the standards of specifying the ratings of electrical equipments.	Un	1,12	1,2
3.	Discuss the standard tests to be conducted on electrical equipments.	Ap	1,12	1,2
4.	Describe the maintenance schedule of various electrical equipments.	Un	1,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✓											✓	✓	✓		✓
2	✓											✓	✓	✓		✓
3	✓											✓	✓	✓		✓
4	✓											✓	✓	✓		✓
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Process of standard specification, installation, tests and commissioning of electrical equipments**	**Power industries and electrical utilities**	**Design and Maintenance engineer**

OPTIMIZATION TECHNIQUES

Course Code	21EEOE661	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand optimization problem definition.
2.	To understand & apply linear programming.
3.	To understand constrained and unconstrained problem solving.
4.	To understand & apply Genetic algorithms and ANN.

Pre-requisites :

Unit – I	**Contact Hours = 8 Hours**
Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria – Review of basic calculus concepts – Global optimality	

Unit – II	**Contact Hours = 8 Hours**
Linear programming methods for optimum design, Post optimality analysis – Application of LPP models in design and manufacturing. Numerical problems.	

Unit – III	**Contact Hours = 8 Hours**
Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.	

Unit – IV	**Contact Hours = 8 Hours**
Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method – Engineering applications of constrained and unconstrained algorithms.	

Unit – V	**Contact Hours = 8 Hours**
Modern methods of Optimization: Genetic Algorithms – Simulated Annealing – Ant colony optimization – Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Deb K. – 'Optimization for Engineering Design Algorithms and Examples' – PHI – 2000
2.	Arora J. – 'Introduction to Optimization Design' – Elsevier Academic Press, New Delhi – 2004
	Reference Books:
1.	Saravanan R. – 'Manufacturing Optimization through Intelligent Techniques' – Taylor & Francis (CRC Press) – 2006
2.	Hardley G. -'Linear Programming' – Narosa Book Distributors Private Ltd. – 2002
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108107113

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the optimization problem definition.	Un	1,2,12	1,3
2.	Describe & apply linear programming.	Un, Ap	1,2,12	1,3
3.	Explain & apply the constrained and unconstrained problem solving.	Un, Ap	1,2,12	1,3
4.	Apply Genetic algorithms and ANN.	Ap	1,2,12	1,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔	✔										✔	✔		✔	
2	✔	✔										✔	✔		✔	
3	✔	✔										✔	✔		✔	
4	✔	✔										✔	✔		✔	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Design, Analyze & Optimize the programs	Power System Design & Operation	Power System Design & Development, Maintenance Engineer

FUZZY LOGIC

Course Code	21EEOE662	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the basic principles of crisp and fuzzy sets.
2.	Summarize theory of approximate reasoning and justify the use of the rules.
3.	Analyze and summarize the FKBC structure and understand the concept of fuzzification and defuzzification
4.	Design a typical fuzzy logic controller for various applications.
5.	Understand the concepts of adaptive mechanism for the fuzzy based controllers.

Pre-requisites: Set Theory, Statistics & Probability.

Unit – I	Contact Hours = 8 Hours
The mathematics of fuzzy control: Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle	

Unit – II	Contact Hours = 8 Hours
Theory of approximate reasoning: Linguistic variables, Linguistic Hedges, Fuzzy proportions, Fuzzy if-then, if_then_else statements, inference rules, compositional rule of inference.	

Unit – III	Contact Hours = 8 Hours
Fuzzy knowledge-based controllers (FKBC): Basic concept of structure of FKBC, choice of membership functions, scaling factors, rules, fuzzification and defuzzification procedures.	

Unit – IV	Contact Hours = 8 Hours
Applications: Simple applications of FKBC such as washing machines, traffic regulations, lift control, aircraft landing Control, Water level control, temperature control.	

Unit –V	Contact Hours = 8 Hours
Adaptive fuzzy control: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria, model based controller.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	nil	nil	nil	nil	nil

Books	
	Text Books:
1.	M Timothy John Ross, "Fuzzy Logic With Engineering Applications", Wiley, Second Edition, 2009.
2.	D. Driankov, H. Hellendoorn and M. Reinfrank , "An Introduction to Fuzzy Control", Narosa Publishers India, 1996.
	Reference Books:
1.	G. J. Klir and T. A. Folger, "Fuzzy Sets Uncertainty and Information", PHI IEEE, 2009
2.	R. R. Yaser and D. P. Filer, "Essentials of Fuzzy Modeling and Control, John Wiley, 2007.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108104157

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the basic concepts of fuzzy sets, operations, properties of fuzzy sets, fuzzy relations, basic features of membership functions, fuzzification process and defuzzification process, and adaptive fuzzy logic.	Un	1,2,3	1
2.	Apply the composition rules and fuzzy if-then rules to the real world problems.	Ap	1,2,3	1
3.	Develop and implement fuzzy systems for real-world applications	Cr	1,2,3,5,9,10	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

	CO-PO Mapping (Planned)												**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✔	✔	✔										✔		
2	✔	✔	✔										✔		
3	✔	✔	✔		✔				✔	✔			✔		
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Logical thinking, implementation of controller logic, model developing using fuzzy systems.**	**R&D, Electronics, Control Systems**	**R&D Engineer**

ELECTRIC VEHICLES

Course Code	21EEOE663	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Demonstrate an understanding of the concept of electric vehicles.
2.	To study about the motors & drives for electric vehicles.
3.	To understand the electronics and sensors in electric vehicles.
4.	To understand the concept of hybrid vehicles.
5.	To study fuel cells for electric vehicles.

Pre-requisites : Basic electrical engineering

Unit – I: Introduction to Electric Vehicles	**Contact Hours = 8 Hours**

Electric Vehicle – Need - Types – Cost and Emission. **Electric Vehicle Technology** – layouts, cables, components, Controls. **Batteries** – overview and its types. Battery plug-in and life. Ultra-capacitor, **Charging** – Methods and Standards. Alternate charging sources – Wireless & Solar.

Self study : History of electric vehicles

Unit – II: Electric Vehicle Motors	**Contact Hours = 8 Hours**

Motors– Types (DC, Induction, BLDC), Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling, Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor Design.

Self study : Planetary gear system.

Unit – III: Electronics and Sensor-less control in EV	Contact Hours = 8 Hours
Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self-drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance- Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.	
Unit – IV: Hybrid Vehicles	**Contact Hours = 8 Hours**
Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV , Layout and Architecture – Series,Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction, Hybrid Electric Vehicles System – Analysis and its Types, Controls. Self study : Hydrogen fuelled transportation.	

Unit – V: Fuel Cells for Electric vehicles	Contact Hours = 8 Hours
Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance. Self study : other energy storage devices.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

TEXT BOOKS	
1	Jack Erjavec and Jeff Arias, “Hybrid, Electric and Fuel Cell Vehicles”, Cengage Learning, 2012.
2	Jack Erjavec and Jeff Arias, “Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles”, Cengage Learning Pvt. Ltd., New Delhi, 2007
3	Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2009.
REFERENCES	
1	Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2	Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.
3	Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
4	Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.
5	Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.
Online courses	
	https://onlinecourses.nptel.ac.in/noc23_ee01/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the working principle of electric vehicles.	Un	1,2,12	1
2.	Explain the construction and working principle of various motors used in electric vehicles.	Un	1,2,12	2
3.	Explain & utilize the working principle of electronics and sensor less control in electric vehicles.	Ap	1,2,12	2
4.	Classify the hybrid vehicles and their working principle.	Un	1,2,12	1
5.	Illustrate the various types and working principle of fuel cells.	Un	1,2	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔											✔	✔	✔		
2		✔										✔	✔	✔	✔	
3	✔											✔	✔			
4		✔												✔		
5			✔									✔			✔	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Classify electric vehicles, optimum choice of EVs, Design & fabrication of EVs	EV-Manufacturing & Transportation sector	EV Design & Maintenance Engineer, Sales Engineer

Nanoscience and Nanotechnology

Course Code	21CH661	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To provide a comprehensive overview of synthesis and characterization of nanoparticles, nanocomposites and hierarchical materials with nanoscale features.
2.	To provide the engineering students with necessary background for understanding various nanomaterials characterization techniques
3.	To develop an understanding of the basis of the choice of material for device applications
4.	To give an insight into complete systems where nanotechnology can be used to improve our everyday life

Pre-requisites : Basics of Chemistry

Unit – I: Introduction to Nanomaterials	Contact Hours = 8 Hours

Nanotechnology, Frontier of future-an overview, Length Scales, Variation of physical properties from bulk to thin films to nanomaterials, Confinement of electron in 0D, 1D, 2D and 3D systems

Synthesis of Nanomaterials: Bottom-Up approach: Chemical Routes for Synthesis of nanomaterials-Sol-gel, Precipitation, Solution Combustion synthesis. Top-Down approach- Ball milling technique, Sputtering, Laser Ablation

LABORATORY ACTIVITIES PLANNED

1) Preparation of silver nanoparticles and characterization of particle size by optical spectroscopy
2) Preparation of ZnO nanoparticles by combustion technique
3) Preparation of Al_2O_3 nanoparticles by precipitation method
4) Preparation of Silica nanoparticles by sol-gel method
5) Hydrothermal synthesis of metal oxide nanoparticles

Unit – II: Characterization of Nanomaterials	Contact Hours = 8 Hours

Basic principles and instrumentations of Electron Microscopy –Transmission Electron Microscope, Scanning Electron Microscope, Scanning Probes- Scanning Tunneling microscope, Atomic Force Microscope –different imaging modes, comparison of SEM and TEM, AFM and STM, AFM and SEM, Porosity (BET method), Zeta potential

Basic principles of working of X-ray diffraction, derivation of Debye-Scherrer equation, numericals on Debye Scherrer equation, Optical Spectroscopy- Instrumentation and application of IR, UV/VIS (Band gap measurement)

Unit – III : Properties of Nanomaterials	Contact Hours = 8 Hours

Electronic and optoelectronic properties: Explanation of Ballistic transport-comparison with superconductor, Coulomb blockade-property-in quantum dot circuit/single electron transistor, Diffusive transport

Dielectric Properties: Polarization, Ferroelectric Behaviour

Optical Properties: Photoconductivity, Optical absorption and transmission, Plasmons and Excitons, Luminescence- Phosphorescence and Fluorescence. Magnetic properties: Nanomagnetism, Magnetoresistance, Super Para Magnetism-Neel Relaxation time, blocking temperature etc.

Unit – IV: Nanotechnology in Energy storage and conversion	**Contact Hours = 8 Hours**
Solar cells: First generation, Second generation and third generation solar cells: Construction and working of Dye sensitized and Quantum dot sensitized solar cells. Batteries: Lithium ion battery- working, Requirements of anodic and cathodic materials, classification based on ion storage mechanisms, limitations of graphite anodes, Advances in Cathodic materials, Anodic materials, Separators Fuel Cells:Introduction, construction, working of fuel cells and nanotechnology in hydrogen storage and proton exchange membranes.	

Unit –V: Nanoelectronics	**Contact Hours = 8 Hours**
Switching glasses, Semiconductor devices including LEDs and Photonic crystals (1D, 2D and 3D) and their applications Photo-electronics: Merger of photonics and electronics at nanoscale dimensions. Single electron devices, molecular circuits, Display devices.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Nano Materials – A.K. Bandyopadhyay/ New Age Publishers
2.	Nanocrystals: Synthesis, Properties and Applications – C.N.R. Rao, P. John Thomas and G. U. Kulkarni, Springer Series in Materials Science
3.	Nano Essentials- T. Pradeep/TMH
	Reference Books:
1.	Introduction to Nanotechnology, C. P. Poole and F. J. Owens, Wiley, 2003.
2.	Understanding Nanotechnology, Scientific American 2002.
	Nanotechnology, M. Wildon, K. Kannagara, G. Smith, M. Simmons and B. Raguse, CRC Press Boca Raton 2002.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Tests (OBT)
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Demonstrate the synthesis of nanoparticles by various techniques.	Un	1	
2.	Explain working of basic instruments used in characterization of nanoparticles.	Un	4	
3.	Discuss the applications of nanotechnology to engineering domains	Un	6	
4.	Classify the nanomaterials based on the dimensions	Un	1	
5	Assess the suitability of nanomaterials for various device applications	An	1, 12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Lab activities	Addition of two open Book Assignments	Course project	Total Marks
Marks	25+25= 50	10	10+10 =20	20	100
Minimum score to be eligible for SEE: 40 OUT OF 100					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✔														
2				✔											
3						✔									
4	✔														
5	✔											✔			
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Synthesis of Nanoparticles	Battery and sensors industries	R & D Scientist
2	Characterization of Nanoparticles	Analytical Instrumentations	Analyst
3	Development of Solar cells and super capacitors	Energy industries	R & D Scientist

ROBOTICS & AUTOMATION

Course Code	21INT61	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	-			SEE Marks	100

Course learning objectives	
1.	Understand the History of Automation and types of Automation. Advantages and Disadvantages of Automation.
2.	Explain and Understand the Flexible Automation Systems and Automated Manufacturing system.
3.	Explain and Understand the Robot Anatomy, Types of Robots and different configuration of Robots, Robots Joints, Work envelope, Robot Drive system.
4.	Understand the Sensors and feedback system used in Robots. Robots control system.
5.	Explain and Understand Machine vision system.
6.	Explain and Understand Robot Programming languages.

Pre-requisites : Robots concepts, videos

Unit – I	Contact Hours = 8 Hours
Automation - History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies Automated Manufacturing Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS. Robotics - Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy.	

Unit – II	Contact Hours = 8 Hours
Types of Robot and Robot configurations: Cartesian, Cylindrical, SCARA (Selective Compliance Assembly Robot Arm or Selective Compliance Articulated Robot Arm), 6 Axis and Delta Robots Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeat-ability, End effectors – Tools and grippers.	

Unit – III	Contact Hours = 8 Hours
Controller and Actuators - Basic robot control system concepts and types. Robot Transfer functions, Block diagrams, characteristic equation, Control system and analysis. Types of Controllers: On-Off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Robot actuation and feedback components Position sensors – Potentiometer, Resolvers, Encoders and Velocity sensors. Actuators - Pneumatic and Hydraulic Actuator, Electric Motors, Stepper motors, Servomotors and Power Transmission systems.	

Unit – IV	Contact Hours = 8 Hours
Robot Sensors and Machine vision system - Sensors in Robotics - Tactile sensors, Proximity and Range sensors, Use of sensors in robotics Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis.	

Unit –V	Contact Hours = 8 Hours
Software Languages used in Robot Programme Different Types of languages used in Robot Programming. Different stop categories and types of Emergency Stops used in programming. Robot Programming – Programme for the movement of ARM, BASE, WRIST, ELBOW, SHOULDER, Pick and Place, Point to Point path control, writing practice.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	NIL	NIL	NIL	NIL	NIL

Books	
	Text Books:
1.	Industrial handbooks, catalogue and data sheets for respective material / system of reputed make.
2.	Robotics from Concept to Consumers by Wil Mara
3.	Robotics –Peter Mckinnon
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	Udemy Courses

Course delivery methods		Assessment methods	
1.	PPT and Videos	1.	IA tests
2.	Factory Visits	2.	Online Quizzes (Surprise and Scheduled)
3.		3.	Open Book Tests (OBT)
4.		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	History of Automation, different types of Automation, Flexible manufacturing Automation	Re, Un	1, 2	1
2.	Definition of Robot, Laws of Robot, Types of Robot, Anatomy of Robots, Different Joints of Robots	Un, Ap	1,2,3,4,5,6	1,2,3
3.	Robot Control System, PID controllers, Accuracy, Robot, Transfer Units, Position Sensors, Actuators	Re, Un	1,2	1
4.	Different types of Sensor in Robots, Machine Vision System in Robots	Re, Un	1,2	1
5.	Different type of Programming Languages used in Robots	Un, Ap	1,2,3,4,5,6,10,11	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	5* 2 marks = 10	10+10 =20	20	100

OBA- Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	Minimum passing marks required to be scored in SEE; 40 out of 100 marks.
3.	Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

	CO-PO Mapping (Planned)												**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√	√	√	√	√							√	√	√
3	√	√											√		
4	√	√											√		
5	√	√	√	√	√	√				√	√		√	√	√
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	Industrial Networking	Automotive Industry	Automation Engineer, Control Systems Engineer
2	Robot Programmer	Automotive Industry, Foundry	Robot Programmer,
3	Control System Design	Pharmaceutical and Chemical Industry, Food and Beverage Industry	Robotics Engineer, Process Control Engineer.

Employability Skills II

Course Code	21AECEE68	Course type	AEC	Credits L-T-P	1 – 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 20 Hrs; T = 0 Hrs; P = 0 Hrs Total = 20 Hrs			CIE Marks	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	These skills make it easier to form relationships with people, create trust and dependability, and lead teams.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Unit – I	Contact Hours = 4 Hours
General Aptitude 1.1: **Understanding Quantitative Aptitude:** Time, Speed, and Distance, Trains, Boats, and Streams	

Unit – II	Contact Hours = 4 Hours
General Aptitude 1.2: **Understanding Quantitative Aptitude:** Permutation and Combination, Probability, Data Interpretation, and Simple and Compound Interest	

Unit – III	Contact Hours = 4 Hours
General Aptitude 1.3: **Understanding Quantitative Aptitude:** Change of Speech & Voice, Sentence Completion, and Critical Reasoning	

Unit – IV	Contact Hours = 4 Hours
General Aptitude 1.4: **Understanding Quantitative Aptitude:** Allegation and Mixtures, Syllogisms, Seating Arrangement, Data Arrangement, Clocks & Calendars, and Data Sufficiency	

Unit – V	Contact Hours = 4 Hours
Improve Sense of Belongingness: Interview Skills and Resume Writing	

Books	
	Text Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1	The Aptitude Triad , BIZOTIC
	Reference Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
		3.	Internal Assessments

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10	
2.	Perform confidently during the Interview process	L2	12	
3.	Develop Resumes that are grammatically correct	L2	10	
4.	Develop behaviors that are appropriate for a professional	L2	12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Assignment	Class Performance	Total Marks
Marks	25+25 = 50	10	15+15 =30	10	100
> Writing 2 IA tests is compulsory **> Minimum score to be eligible for SEE: 40 OUT OF 100**					

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										✓		✓			
2										✓		✓			
3										✓		✓			
4										✓		✓			
5										✓		✓			
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Logical Thinking	IT Industry	Software Engineer
2	Problem Solving	Automotive	Developer
3	Communication Skills	Education Sector	Project Manager

7th SEMESTER

Electric Drives and Traction

Course Code	21EE71	Course type	PCC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0– 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 00 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	05 Hours			SEE Marks	100

Course learning objectives	
1.	To understand & explain general electric drive & dynamics principles.
2.	To understand & explain types of electric drives, power ratings, performance characteristics, analysis & selection of DC and AC drives.
3.	To understand & explain operation & speed/torque control techniques for DC & AC drives.
4.	To understand & analyze braking techniques for DC and AC drives.
5.	To Explain the basics of electric traction & analyze the performance.

Unit – I	Contact Hours = 8 Hours
Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives. **Dynamics of Electrical Drives:** Fundamental Torque Equations, Speed Torque Conventions and Multi-quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization.	

Unit – II	Contact Hours = 8 Hours
Direct Current Motor Drives: Speed torque characteristics of different types of DC motors, speed Control of DC Separately Excited Motor using single phase fully controlled rectifier, Speed Control using a single phase half controlled rectifier. Three Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Three Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Chopper Controlled DC drive, braking of DC motors, Numerical	

Unit – III	Contact Hours = 8 Hours
Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing. Variable voltage, variable Frequency Control. Voltage source inverter Control, Variable Voltage Frequency Control. Current Source inverter control. Static rotor resistance control. Slip power recovery (static-scherbius) drive, braking of Induction motor, Numerical.	

Unit – IV	Contact Hours = 8 Hours
Rating and braking of motors: Thermal model of motor for heating and cooling (No numerical analysis). Classes of motor duty cycle. Determination of motor rating. Braking of DC motor. Braking of 3 phase Induction motor.	

Unit – V	Contact Hours = 8 Hours
Electric Traction: Requirements of ideal traction. System of traction. Speed - time curve. Tractive effort coefficient of adhesion. Selection of traction motor. Specific energy. Factors affecting specific energy consumption. Self learning topics: Hybrid Vehicles.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	**2** Steady state stability. Load equalization	**2** Braking of 3 phase induction motor	**2** Chopper controlled DC drive	**2** Slip power recovery	**2** Factors affecting specific energy consumption.

Books	
	Text Books:
1.	G.K.Dubey, “Fundamentals of Electrical Drives”, Narosa Publications.
2.	S.L.Uppal, “Electrical Power”, Khanna Publishers.
	Reference Books:
1.	S.K. Pillai, “First Course in Electrical Drives” , TMH Publications.
2.	N.K.De and P.K.Sen, “Electrical Drives”, TMH Publication
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	Udemy.com/course/electric-motor-drives-induction-motor

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain general electric drive & dynamics principles.	Un	1, 12	1,2
2.	Explain types of electric drives, power ratings, performance characteristics, analysis & selection of DC and AC drives.	Un,Ap	1,12	1,2
3.	Explain operation & speed/torque control techniques for DC & AC drives.	Un,Ap	1,2, 4,5,12	1,2
4.	Analyze braking techniques for DC and AC drives.	An	1,3,12	1,2
5.	To Explain the basics of electric traction & analyze the performance.	Un, An	1,3,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔											✔	✔	✔		
2	✔											✔	✔	✔		
3	✔	✔		✔	✔							✔	✔	✔		
4	✔		✔									✔	✔	✔		
5	✔		✔									✔	✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Selection of AC and DC drives & control**	**Railways, Foundries, Factories**	**Drive Engineer, Traction controller, Maintenance Engineer**

EMBEDDED SYSTEMS

Course Code	21EEPE721	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Explain the ARM processor fundamentals and ARM cortex M3 in particular.
2.	Explain the architecture of LPC1768, instruction set and programming.
3.	Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
4.	Develop the hardware software co-design and firmware design approaches.
5.	Explain the need of real time operating system for embedded system applications.

Pre-requisites : Microcontrollers

Unit – I: ARM PROCESSOR FUNDAMENTALS	Contact Hours = 8 Hours
Introduction, Processor Modes, Processor families and architecture versions, Pipeline, Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence.	

Unit – II : ARM Cortex M3	Contact Hours = 8 Hours
ARM Cortex M3 LPC 1768 Architecture, Features and applications, Memory Map, Introduction to ARM instruction Set, Thumb Instruction Set, Programming the LPC 1768: Pin connect block, GPIO, UART.	

Unit – III:	Contact Hours = 8 Hours
Embedded System Components: Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Elements of an Embedded System (Block diagram and explanation), Differences between RISC and CISC, Harvard and Princeton, Big and Little Endian formats, Memory (ROM and RAM types), Sensors, Actuators, Optocoupler, Communication Interfaces (I2C, SPI, IrDA, Bluetooth, Wi-Fi, Zigbee only)	

Unit – IV	Contact Hours = 8 Hours
Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modeling (excluding UML), Embedded firmware design and development (excluding C language)	

Unit –V	Contact Hours = 8 Hours
RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil), Disassembler/decompiler, simulator, emulator and debugging techniques	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd Edition, Newnes, (Elsevier), 2010
2.	Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, 2nd Edition.
3.	A.N. Sloss, D. Symes and C. Wright, “ARM System Developer’s Guide: Design and Optimizing System Software”, Morgan Kaufman Publishers, 2004.
	Reference Books:
1.	James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008, ISBN: 978-0- 471-72180-2.
2.	Yifeng Zhu, “Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C”, 2nd E -Man Press LLC ©2015 ISBN:0982692633 9780982692639.
3.	Embedded real time systems by K.V. K. K Prasad, Dreamtech publications, 2003.
4.	Embedded Systems by Rajkamal, 2nd Edition, McGraw hill Publications, 2010
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108102045
2.	https://archive.nptel.ac.in/courses/106/105/106105193/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain the ARM processor fundamentals; outline the features of LPC 1768 processor and its pin connect block for various applications.**	Un,Ap	1,5,12	3
2.	Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	Un	1,12	3
3.	Understand the hardware software co-design and firmware design approaches.	Un	1,12	3
4.	Explain the need of a real time operating system for embedded system applications.	Un	1,12	3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔				✔							✔			✔	
2	✔				✔							✔			✔	
3	✔											✔			✔	
4	✔											✔			✔	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Knowledge of ARM processors & Embedded Systems	Mobile Application Development, Aerospace, Automotive, Construction, Information Technology, Healthcare.	Embedded & Control System Engineer

HVDC and FACTS

Course Code	21EEPE722	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand and explain the differences between A.C and D.C transmission systems and explain control features in D.C systems.
2.	Understand of the aspects of FACTS, basic types of controllers and concepts of various voltage sourced converters.
3.	Understand and explain the Series and shunt compensation operation.

Pre-requisites: Basic Electrical engineering, Transmission & Distribution, Power Systems, HVE

Unit – I	Contact Hours = 8 Hours
Constitution of EHV A.C and D.C lines, kinds of D.C. links, important D.C. links in the world and in India, limitations and advantages of A.C and D.C transmissions, principle applications of D.C transmissions, economic factors.	

Unit – II	Contact Hours = 8 Hours
Converter circuit and control-12 pulse converter, grid control, basic means of control, power reversal, desired features of control, types of control, combined characteristics of rectifier and inverter, new trends in D.C lines.	

Unit – III	Contact Hours = 8 Hours
FACTS Concepts: Types of transmission line, equivalent circuit of a transmission line, performance requirement of transmission line, derivation for active and reactive power flow in transmission line in short transmission line, transmission line inter connections, power flow in an AC system, loading capability limits, dynamic stability considerations, importance of controllable parameters,	

Unit – IV	Contact Hours = 8 Hours
Voltage Source Converters: Basic types of FACTS controllers, benefits from FACTS controllers. Basic concept of voltage source converters, single phase and three phase full wave bridge converters, basic concept of current source converters. Static Shunt Compensation: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, methods of controllable var generation, variable impedance type static var generators, TCR & TSCoperation and its VI Characteristics.	

Unit –V	Contact Hours = 8 Hours
SVC and STATCOM: TSC –TCR, FC TCR operation, its VI characteristics. Basic operating principles of STATCOM. Static Series Compensation: Concept of series capacitive Compensation, improvement of transient stability, sub synchronous oscillation damping, Thyristor switched series capacitor (TSSC) and Thyristor controlled series capacitor (TCSC),	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	02	02	02	02	02

Books	
	Text Books:
1.	"**Direct Current Transmission**" by EW Kimbark
2.	**"High Voltage Direct Current Transmission"** by Jos Arrillaga, 2nd edition, Power and energy series 29IET.
3.	"Understanding FACTS Devices" N.G. Hingorani and L.Guygi IEEE Press Publications 2000.
4.	K.R. Padiyar, "FACTS - Controllers in Power Transmission distribution", New age publishers.
	Reference Books:
1.	**"HVCTransmission"**bySKamakshaiahandVkamaraju.TataMcGrawHillEduPvtLtd
2.	S.Rao,Khanna publishers, "EHV - AC, HYDC Transmission & Distribution Engineering", 3rd edition.
	E-resources (NPTEL/SWAYAM.. Any Other)-
1.	https://archive.nptel.ac.in/courses/108/107/108107114/
2.	https://archive.nptel.ac.in/courses/108/108/108108099/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the comparison of AC and DC systems with design consideration of DC system.	Un	1,2,7,12	2
2.	Explain and apply basic FACTS controller with various voltage source converter.	Ap	1,2,7,12	2
3.	Explain and select suitable configuration for the system from a list of shunt &series compensation circuits.	Un	1,2,7,12	2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment

Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔	✔					✔						✔	✔		
2	✔	✔					✔						✔	✔		
3	✔	✔					✔						✔	✔		
4	✔	✔					✔						✔	✔		
5	✔	✔					✔						✔	✔		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Planning , Design & Operation of HVDC & FACTs devices	Power Systems & Grids, Railways	Power System R&D Engineer, HV Engineer.

SMART GRIDS

Course Code	21EEPE723	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the need for smart grid and challenges in implementation of smart grid.
2.	Understand and explain the Substation Automation, Feeder Automation.
3.	Identify and describe the issues of power quality aspects in smart grids.
4.	Understand the concepts of smart metering and PMU.
5.	Demonstrate an understanding of micro grids and distributed energy resources.

Pre-requisites: Power system analysis, Renewable energy sources, Power Generation, Transmission & Distribution.

Unit – I	Contact Hours = 8 Hours
Evolution of electric grid, concept, definitions and need for smart grid, smart grid drivers, functions, opportunities, challenges and benefits, difference between conventional & smart grid, present development & international policies in smart grid.	

Unit – II	Contact Hours = 8 Hours
Smart energy resources, smart substations, substation automation, feeder automation , Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, protection and control, Distribution systems: DMS, Volt/VAr control, fault detection, isolation and service restoration, outage management, high-efficiency distribution transformers, phase shifting transformers, plug in hybrid electric vehicles (PHEV).	

Unit – III	Contact Hours = 8 Hours
Power Quality Management in Smart Grid Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.	

Unit – IV	Contact Hours = 8 Hours
Introduction to smart meters advanced metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor measurement unit (PMU), intelligent electronic devices (IED) & their application for monitoring & protection.	

Unit – V	Contact Hours = 8 Hours
Micro grids and Distributed Energy Resources Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards", IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2.	Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE communication survey and tutorials, vol-14, issue 4, 2012.
3.	C. Sankaran, "Power Quality", CRC Press LLC, 2002.
	Reference Books
1.	Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press.
2.	Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley publications.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108107113
2.	https://onlinecourses.nptel.ac.in/noc21_ee68/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the need for smart grid and challenges in implementation of smart grid.	Un	1,2,4, 5,12	1,2
2.	Understand and explain the Substation Automation, Feeder Automation	Un	1,2,4, 5,12	1,2,3
3.	Identify and describe the issues of power quality aspects in smart grids.	Un	1,24,5 ,12	1
4.	Describe the concepts of smart metering and PMU.	Un	1,2,12	2
5.	Demonstrate an understanding of micro grids and distributed energy resources	Un	1,2,4, 5,7	3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✔			✔	✔							✔	✔	✔		
2		✔		✔	✔							✔	✔	✔	✔	
3	✔			✔	✔							✔	✔			
4		✔		✔	✔									✔		
5			✔	✔	✔		✔					✔			✔	
Tick mark the CO, PO and PSO mapping																

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Planning, Design & Maintenance of Smart grids, Handling of Automation & Control tools**	**Power Systems**	**Automation & Control Engineer, Power System design & planning engineer.**

MODERN CONTROL THEORY

Course Code	21EEPE724	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Define State model and classify and construct state models for LTI systems and demonstrate their applications.
2.	Demonstrate an understanding of analysis of systems using state models in terms Eigen values, Eigen vectors, state transition matrix.
3.	Assess the controllability and observability of a system and design controller and observer for a given system.
4.	Identify and understand the common physical nonlinearities and describe their properties.
5.	Assess and analyze the stability of nonlinear systems using Phase plane trajectory.

Pre-requisites : Matrix algebra, Laplace transformation, Control Systems.

Unit – I	Contact Hours = 8 Hours
State variable analysis and design: Introduction, concept of state, state variables and state model, state modeling of linear systems and linearization of state equation. State space representation using physical variables .	

Unit – II	Contact Hours = 8 Hours
State space representation using phase variables and canonical variables, derivation of transfer function from state model, diagonalization, Eigen values, eigen vectors, generalized eigen vectors. MATLAB/Simulink simulations	

Unit – III	Contact Hours = 8 Hours
Solution of state equation, state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley-Hamilton method. Total response of a system. MATLAB/Simulink simulations	

Unit – IV	Contact Hours = 8 Hours
Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design and design of state observer, concept of controllability & observability, methods of determining the same and duality principle. MATLAB/Simulink simulations.	

Unit – V	Contact Hours = 8 Hours
Non-linear systems: Introduction, behavior of non-linear systems, common physical non linearity's saturation, friction, backlash, dead zone, relay, multi variable non-linearity. **Self-learning topics: Phase plane analysis:** Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories. Self-Learning Topics: Phase Plane Analysis	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

	Books
	Text Books:
1.	I. J. Nagarath & M. Gopal, "Control system Engineering", New Age International (P) Ltd, 3rd edition.
2.	Benjamin C. Kuo & Farid Golnaraghi, "Automatic Control Systems",8th edition, John Wiley & Sons 2009.
3.	Katsuhiko Ogata, "Modern Control Engineering",PHI,5th Edition, 2010.
	Reference Books:
1.	M. Gopal ,"Digital control & state variable methods",3rd Edition, TMH ,2008.
2.	Dorf & Bishop, "Modern control systems", Pearson education, 11th Edition 2008.
	Katsuhiko Ogata , "State Space Analysis of Control Systems", PHI.
1.	**E-Resources**: NPTEL online Course "**Advanced Continuous Control Systems with MATLAB/Simulink"**
2.	https://onlinecourses.nptel.ac.in/noc19_ee45/announcements?force=true

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Define & explain** concepts of state space techniques.	Un	1,2,5,12	1,3
2.	*Apply* the state space techniques to form different models of physical systems.	Un, Ap	1,2,5,12	1,3
3.	*Evaluate* the system stability using state space techniques such as STM, controller & observer.	Un, Ap	1,2,5,12	1,3
4.	*Design* of controller & observer.	Ap	1,2,3,12	1,3
5.	*Understand & explain* nonlinear systems & evaluate stability.	Un, Ap	1,2,5,12	1,3

Scheme of Continuous Internal Evaluation (CIE): **Theory course**

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔	✔			✔							✔	✔		✔	
2	✔	✔			✔							✔	✔		✔	
3	✔	✔			✔							✔	✔		✔	
4	✔	✔	✔									✔	✔		✔	
5	✔	✔			✔							✔	✔		✔	
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Modeling physical systems, assess performance & stability.	Automation & Control process	Maintenance, Control and Automation Engineer

Renewable Energy Sources

Course Code	21EEPE725	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand energy scenario, energy sources and their utilization.
2.	To explore society's present needs and future energy demands.
3.	To Study the principles of renewable energy conversion systems.
4.	To understand &implement energy conservation methods.

Pre-requisites : Basic Electrical Engineering, Engineering Physics.

Unit – I	Contact Hours = 8 Hours
Introduction: Principle of renewable energy; energy and sustainable development, per capita energy consumption, fundamental and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, Introduction to Internet of energy (IOE). comparison of conventional and non-conventional energy resources	

Unit – II	Contact Hours = 8 Hours
Solar Energy: Fundamentals: Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Sunshine Recorder. **Solar Thermal systems**: Principle of conversion of solar radiation into heat, solar water heaters (Flat Plate Collectors), solar cookers – Box type, concentrating dish type, solar driers, solar still, solar furnaces, solar green houses. **Solar thermal electric power generation**- solar pond and Central Tower Collector, Advantages and disadvantages.	

Unit – III	Contact Hours = 8 Hours
Solar PV Systems: Solar cell fundamentals, characteristics, classification, construction of module, design of solar panel and array, stand-alone and grid connected; Applications – Street lighting, domestic lighting and solar water pumping systems.	

Unit – IV	Contact Hours = 8 Hours
Wind Energy: Introduction, wind and its properties, wind energy scenario in World and India. Basic principles of Wind Energy Conversion Systems (WECS), classification of WECS, parts of WECS, estimation of Power in the wind, wind site selection consideration, advantages and disadvantages of WECS. **Biomass Energy:** Introduction, biomass fuels, biomass conversion technologies, urban waste to energy conversion, biomass gasification (Downdraft), biomass to ethanol production, factors affecting biogas generation, Biomass conversion technologies-fixed dome.	

Unit –V	Contact Hours = 8 Hours
Tidal Power: Introduction; harnessing tidal energy, advantages and limitations. **Ocean Thermal Energy Conversion**: Principle of working, OTEC power stations in the world, problems associated with OTEC. **Green Energy:** Introduction, Fuel cells: alkaline fuel cells, Acidic fuel cells, SOFC – emerging areas in fuel cells	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2.	Khan B. H., "Non-Conventional Energy Resources", TMH, New Delhi, 2006 and onwards
	Reference Books:
1.	Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018
2.	Principles of Energy conversion, A. W. Culp Jr.,, McGraw Hill, 1996 2. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/103103206
2.	https://www.edx.org/professional-certificate/imperialx-clean-power?webview=false&campaign=Clean+Power&source=edx&product_category=professional-certificate&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fsustainable-energy

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the renewable energy concept.	Un	1,6,7,9,10,11,12	1,2,4
2.	Explain the power generation by various renewable energy sources	Un	1,6,7,9,10,11,12	1,2,4
3.	Plan & Design Solar & Wind energy systems.	Cr	1,3,6,7,9,10,11,12	1,2,4

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	✓					✓	✓		✓		✓	✓	✓	✓		✓
2	✓					✓	✓		✓		✓	✓	✓	✓		✓
3	✓		✓			✓	✓		✓		✓	✓	✓	✓		✓
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Designing of Solar Application	Solar & Wind Power industry	Design/Site Engineer
2	Renewable Energy Consultant	Renewable Industry	Energy Consultant

Electrical Energy Conservation and Auditing

Course Code	21EEOE731	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand energy production, consumption, pricing, security, conservation and energy conservation Act-2001 and its features.
2.	Understand the concepts of energy efficiency in electrical systems.
3.	Understand the elements of energy audits.
4.	Understand & apply energy audits to buildings.
5.	Understand different concepts of demand side management.

Pre-requisites: Basic electrical engineering, Electrical distribution system, Electrical estimation and costing, basics of power system.

Unit – I	Contact Hours = 8 Hours
Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.	

Unit – II	Contact Hours = 8 Hours
Energy Efficiency in Electrical Systems: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Electronic ballast, Energy efficient lighting and measures of energy efficiency in lighting system.	

Unit – III	Contact Hours = 8 Hours
Energy Auditing: Introduction, Principles of Energy management, elements of energy audits, ten steps methodology for detailed energy audit, functions of energy audit team, energy use profiles, measurements in energy audits, presentation of energy audit results.	

Unit – IV	Contact Hours = 8 Hours
Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Building	

Unit – V	Contact Hours = 8 Hours
Demand side Management: Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Wayne C. Turner, Steve Doty, **"Energy Management Handbook"**, CRC Press, 6th Edition.
2.	Albert Thumann, **"Fundamentals of Energy Engineering",** Prentice Hall Inc, Englewood Cliffs, New Jersey.
3.	H.E. Jordan, **"Energy Efficient Electric Motors and Applications",** Plenum Pub. Corp
4.	A S. Pabla, **"Electrical Power distribution",** TMH, 5th edition.
	Reference Books:
1.	D.P.Sen, K.R.Padiyar, Indrane Sen, M.A.Pai, **"Recent Advances in Control and Management of Energy Systems",** Interline Publisher, Bangalore.
2.	Ashok V. Desai, **"Energy Demand – Analysis, Management and Conservation",** Wiley Eastern.
3.	J. Andrews, N. Jelley ,**"Energy Science Principles, Technologies and Impact",** Oxford University Press.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc23_me122/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Analyze** energy scenario nationwide and worldwide, also outline Energy Conservation Act and its features.	Un	1,6, 7, 11, 12	1,2,4
2.	**Discuss** load management techniques and energy efficiency.	Un	1,6, 7, 11, 12	1,2,4
3.	**Understand** the need of energy audit and energy audit methodology.	Un	1,6, 7, 11, 12	1,2,4
4.	**Apply** various methods to Conduct energy audit of electrical systems and buildings.	Un,Ap	1,6, 7, 11, 12	1,2,4
5.	Understand & Explain demand side management and energy conservation.	Un	1,6, 7, 11, 12	1,2,4

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment

Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 35%, however overall score of CIE + SEE should be ≥ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔					✔	✔				✔	✔	✔	✔		✔
2	✔					✔	✔				✔	✔	✔	✔		✔
3	✔					✔	✔				✔	✔	✔	✔		✔
4	✔					✔	✔				✔	✔	✔	✔		✔
5	✔					✔	✔				✔	✔	✔	✔		✔
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Understand the current energy scenario and importance of energy conservation. Analysis of energy Scenario & Energy efficiency.	**All Process industries**	**Electrical Maintenance Engineer / Energy Auditor/Consultant**
2	Understand the methods of improving energy efficiency in different electrical systems.	**All Process industries**	**Electrical Maintenance Engineer / Energy Auditor**
3	Realize energy auditing and scope of demand side management, its concept and implementation issues and strategies	**All Process industries**	**Electrical Maintenance Engineer / Energy Auditor**

Solar and Wind Energy

Course Code	21EEOE732	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	-			SEE Marks	100

Course learning objectives	
1.	To understand the principles of wind and solar energy and their significance in the field of renewable energy.
2.	To understand the design and operation of wind turbines and solar panels.
3.	To understand the various techniques for harnessing wind and solar energy and their applications in various sectors.
4.	To understand the environmental, economic, and social benefits of wind and solar energy systems.

Pre-requisites : Basic Electrical Engineering

Unit – I	Contact Hours = 8 Hours
Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface.	

Unit – II	Contact Hours = 8 Hours
Solar Thermal systems: Principle of conversion of solar radiation into heat, solar water heaters (Flat Plate Collectors), solar cookers – Box type, concentrating dish type, solar driers, solar still, solar furnaces, solar green houses. **Solar thermal electric power generation** –Introduction, solar pond, concentrating solar collector (parabolic trough, parabolic dish, Central Tower Collector). Advantages and disadvantages	

Unit – III	Contact Hours = 8 Hours
Solar PV Systems: Solar cell fundamentals, characteristics, classification, construction of module, panel and array, MPPT, balance of system, stand-alone solar PV system and grid connected solar PV system, Applications –solar Street lighting, solar domestic lighting system and solar water pumping systems	

Unit – IV	Contact Hours = 8 Hours
Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario-World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations Wind energy systems: Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis	

Unit –V	Contact Hours = 8 Hours
Basic Components of a Wind Energy Conversion(WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	nil	nil	nil	nil	nil

Books	
	Text Books:
1.	B. H. Khan, “Non-Conventional Energy Resources”, McGraw Hill, 2nd Edition 2017
2.	Rai G. D., “Non-Conventional Energy Resources”, Khanna Publishers, 4th Edition
	Reference Books:
1.	Ahmad Hemami, “Wind Turbine Technology”, Cengage, 1st Edition 2012
2.	Chetan shingh solanki, “Solar Photovoltic technology and systems”, PHI publication
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/103/103/103103206/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the fundamentals of solar & Wind energy and their significance in the field of renewable energy.	Un	1,6,7,9,10,12	1,2,4
2.	Explain the design and operation of wind turbines, solar thermal and solar PV systems	Un	1,6,7,9,10,12	1,2,4
3.	Demonstrate knowledge of the various techniques for harnessing wind and solar energy and their applications in various sectors.	Un	1,6,7,9,10,12	1,2,4
4.	Evaluate the environmental, economic, and social benefits of wind and solar energy systems.	Ev	1,6,7,9,10,12	1,2,4

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✔					✔	✔		✔	✔		✔	✔	✔		✔
2	✔					✔	✔		✔	✔		✔	✔	✔		✔
3	✔					✔	✔		✔	✔		✔	✔	✔		✔
4	✔					✔	✔		✔	✔		✔	✔	✔		✔
	Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Designing of Solar PV & Solar thermal systems	**Renewable Energy Industry & Power Sector**	**Solar & Wind Design Engineer, Consultant**

Energy Storage Systems

Course Code	21EEOE733	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the principles behind the design and operation of battery/storage technology systems
2.	Analyze and evaluate different battery technologies available in the market
3.	Design and develop energy storage solutions using battery technology
4.	Understand the impact of battery technology on the environment and the society

Pre-requisites: Basics cell chemistry.

Unit – I ENERGY STORAGE	Contact Hours = 8 Hours
Necessity of energy storage, Battery Basics, Introduction to Electric Vehicle Batteries, Fuel Cell Technology, Choice of a Battery Type for Electric Vehicles.	

Unit – II ELECTROCHEMICAL BATTERY	Contact Hours = 8 Hours
Electrochemical batteries, Electrochemical reactions, States of the battery, thermodynamic voltage, specific energy, specific power, energy efficiency.	

Unit – III MODERN STORAGE SYSTEMS	Contact Hours = 8 Hours
Ultra capacitors: Features, basic principle, performance, ultra capacitors technology, Advanced materials and technologies for super capacitors **Flywheels**: Principle of operation, power capacity, Flywheel technology.	

Unit – IV Lithium Ion Battery	Contact Hours = 8 Hours
Principle of operation , Lithium-Metal Polymer Batteries, Li – Air batteries, Li – Sulphur batteries, Li resources and recycling of Li ion batteries	

Unit –V Hybrid Energy Storage	Contact Hours = 8 Hours
Concept of Hybrid energy storage, passive and active hybrid energy storage with batteries & ultra-capacitors, Applications of energy storage systems, UPS, battery bank systems, electric vehicles.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	02	02	02	02	02

Books	
	Text Books:
1.	Mehrdad Ehsani , Yimin Gao, Stefano Longo, Kambiz Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, 2018
2.	Bruno Scrosati, Jürgen Garche, Werner Tillmetz, “Advances in Battery Technologies for Electric Vehicles”, Woodhead Publishing Series in Energy, 1st Edition, 2015
3.	Christian Glaize, Sylvie Genies, “Lithium Batteries and other Electrochemical Storage Systems”, Wiley-ISTE, July 2013
	Reference Books:
1.	Mehrdad Ehsani , Yimin Gao, Stefano Longo, Kambiz Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, 2018
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/113/105/113105102/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the necessity of Energy Storage system & types.	Re, Un	1, 6, 7	1
2.	Explain the construction & operation of different types of batteries.	Re, Un	1, 6, 7,12	1, 2
3.	Explain the basics of modern battery technology.	Re, Un	1, 6, 7, 12	1, 2
4.	Explain the applications of various types of batteries.	Re, Un, Ap	1, 6, 7, 12	1, 2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment

Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
1	√					√	√						√			
2																
3	√					√	√					√	√	√		
4	√					√	√					√	√	√		
5	√					√	√					√	√	√		
Tick mark the CO, PO and PSO mapping																

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Operation & Maintenance of batteries.	Electric Vehicle (EV) Industry, Renewable Energy Storage, Consumer Electronics, Aerospace and Defense, Medical Devices, Industrial Automation and Robotics, Energy Management and Grid Storage, Battery Manufacturing	1.Batter Management/marketing Engineer 2.Battery Researcher
2	The course will equip you with the skills to design and develop battery systems tailored to specific applications.		
3	Battery Management Systems (BMS)		

Internet of Things and Artificial Intelligence

Course Code	21INT71	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	-			SEE Marks	100

Course learning objectives	
1.	Understand the Architectural Overview of IOT and Design principles. Basics of Networking, Security aspects of IOT.
2.	Explain and Understand the Elements of IOT Hardware Components and the Software programming.
3.	Explain and Understand the Software frame work for IOT applications.
4.	Explain and Understand the Data acquisition and integration. Storing of data on server/clouds.
5.	IOT Case Studies.
6.	Understand the concept of AI, types of AI, purpose of AI,
7.	Understand Why AI is important. Advantages and disadvantages of AI, Risks of AI.

Pre-requisites : Basics of Networking, Concepts of IOT and AI

Unit – I	Contact Hours = 8 Hours
Introduction to IOT- Architectural Overview, Design principles and needed capabilities, IOT applications, Basics of Networking, Security aspects of IOT. Business Process in IOT. Elements of IOT- Hardware components – Computing (Arduino, Raspberry Pi)	

Unit – II	Contact Hours = 8 Hours
Communications, I/O interfaces, Sensing Actuators. Programming Apps using Python, Arduino for communication. Communication Protocols – Zig-bee, Bluetooth TCP (Transmission Control Protocol), UDP (User Data-gram Protocol)	

Unit – III	Contact Hours = 8 Hours
IOT Application Development - Software frame work for IOT applications, Implementation of Device integration, Data acquisition and integration. Storing of data on server / clouds.	

Unit – IV	Contact Hours = 8 Hours
IOT case Studies - IOT case studies and mini projects interfacing Mechanical, Electrical and Electronics components using Arduino, Raspberry, Pi boards	

Unit –V	Contact Hours = 8 Hours
Artificial Intelligence -What is AI, types of AI, purpose of AI, Why AI is important. Advantages and disadvantages of AI, Risks of AI. Future of AI Case Study in below category •Transportation •Manufacturing •Health Care •Education •Media •Customer Service	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	NIL	NIL	NIL	NIL	NIL

Books	
	Text Books:
1.	Industrial handbooks, catalogue and data sheets for respective material/system of reputed make.
2.	Artificial Intelligence for Robotics- Book by Francis X. Govers
3.	Intelligent Control of Robotic Systems- By Laxmidhar Behera
4.	

Course delivery methods		Assessment methods	
1.	PPT and Videos	1.	IA tests
2.	Visit to Factory for Practicals	2.	Online Quizzes (Surprise and Scheduled)
3.		3.	Open Book Tests (OBT)
4.		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Introduction to IOT- Architectural Overview, Basics of Networking, IOT applications	Re, Un	1,2	1
2.	Elements of IOT, Programming using different languages	Un, Ap	1,2,3,5,6	1,2,3
3.	IOT application development, Implementation of Device integration	Ap, An	1,2,3,4,5,10,11	1,2,3
4.	IOT case studies, Interfacing of Mechanical, Electrical and Electronic components	Ap, An	1,2,3,4,5,10,11	1,2,3
5.	What is AI, Types of AI, Purpose of AI, Risk of AI, different case studies of AI	Ap, An	1,2,3,4,5,10,11	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	5* 2 marks = 10	10+10 =20	20	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	Minimum passing marks required to be scored in SEE; 40 out of 100 marks.
3.	Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√	√	√	√					√	√		√	√	√
3	√	√	√	√	√					√	√		√	√	√
4	√	√	√	√	√					√	√		√	√	√
5	√	√	√	√	√					√	√		√	√	√
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	Programming Engineer	Pharmaceutical and Chemical Industry, Food and Beverage Industry	Embedded Programming Engineer
2	Industrial Networking	Automotive Industry	Automation Engineer, Control Systems Engineer
3	Control System Design	Pharmaceutical and Chemical Industry, Food and Beverage Industry	Process Control Engineer.

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