KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

UDYAMBAG, BELAGAVI-590008

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)

(APPROVED BY AICTE, NEW DELHI)

Fifth to Eighth semester B.E.

(2022 Scheme)

DEPT OF ELECTRICAL & ELECTRONICS ENGINEERING

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
3rd to 8thsem B.E.
Scheme of Teaching and Examination- 2022
Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2023-24)

Total credits for B.E. Program: 160

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

Semester wise distribution of credits for B.E program

Year	Semester	Credits	Total/Year	Cumulative Credits
1st	I	20	40	40
	II	20		
2nd	III	20	40	80
	IV	20		
3rd	V	22	40	120
	VI	18		
4th	VII	24	40	160
	VIII	16		
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, Health and Management)	9	10
2	Basic Science courses	22	22
3	Engineering Science courses including ETC, PLC & Drawing	24	24
4	Professional Core Courses	54	54
5	Professional Elective courses relevant to chosen specialization/branch	12	12
6	Open subjects – Electives from other technical, emerging, arts, commerce	9	9
7	Mini, Project, Major Project work and Seminar	10	9
8	Summer Internship and Research /Industrial Internship	10	10
9	Ability Enhancement Courses, including Research Methodology, NCC/NSS/ Sports/Ex- Curricular, Online Certification Course	8	8
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.SEE can include questions from practical topics.

SDA-Skill Development Activities, TD/PSB- Teaching Department / Paper Setting Board, ASC-Applied Science Course, ESC- Engineering Science Courses, ETC- Emerging Technology Course, AEC- Ability Enhancement Course, HSMS-Humanity and Social Science and Management Course, SDC- Skill Development Course,

KLS Gogte Institute of Technology

3rdYear B.E. Scheme of Teaching and Examination 2022

5th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	HSMS	22EE51	Industrial Management, Electrical estimation & costing	EE	3	0	0	03	3	100	100	200
2	IPCC	22EE52	Operational Amplifiers and applications	EE	3	0	2	05	4	100	100	200
3	PCC	22EE53	Control Systems	EE	4	0	0	04	4	100	100	200
4	PEC	22EEPE54X	Professional Elective Course	EE	3	0	0	03	3	100	100	200
5	PROJ	22EE55	Mini Project	EE	0	0	4	04	2	100	-	100
6	AEC	22EE56	Research Methodology and IPR		2	0	0	02	2	100	100	200
7	AEC	22EE57	Employability Skills -1	Bizotic	1	0	0	01	1	100	-	100
8	MC	22EE58A	Environmental Studies	Civil	2	0	0	02	2	100	100	200
10	MC	22EE58C1	National Service Scheme (NSS)	NSS coordinator	0	0	2		0	100	-	100
		22EE58C2	Physical Education (PE) (Sports and Athletics) and Yoga	Physical Education dept& Yoga instructor								
		22EE58C3	Clubs- Social, Cultural & Academic	Coordinators								
11	PCCL	22EEL59	Electrical & Electronics Measurements Lab	EE	0	0	2	02	1	50	50	100
Total									**22**	**950**	**650**	**1600**

Professional Elective Course

22EEPE541	Fuzzy Logic and applications	22EEPE544	Advanced Power Electronics
22EEPE542	PLC & Industrial Automation	22EEPE545	Energy Storage Systems
22EEPE543	Renewable Energy Sources		

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **PROJ**: Project /Mini Project. **PEC**: Professional Elective course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga/Clubs: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga(YOG) and Clubs with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Club activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands-on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. 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 to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project publication/technical paper, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project publication/technical paper, project presentation skills, and question-answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

6th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	IPCC	22EE61	IoT and Data Acquisition	EE	3	0	2	05	4	100	100	200
2	PCC	22EE62	Power System Analysis	EE	4	0	0	04	4	100	100	200
3	PEC	22EEPE63X	Professional Elective Course	EE	3	0	0	03	3	100	100	200
4	OEC	22EEOE64X	Open Elective Course	EE	3	0	0	03	3	100	100	200
5	PROJ	22EE65	Major Project Phase I		0	0	4	04	2	100	--	100
6	AEC/SDC	22AECEE66	Ability Enhancement Course/Skill Development Course V- **Employability Skills -2**	Bizotic	1	0	0	01	1	100	-	100
7	MC	22EE671	National Service Scheme (NSS)	NSS coordinator	0	0	2		0	100	--	100
		22EE672	Physical Education (PE) (Sports and Athletics) and Yoga	Physical Education dept& Yoga instructor								
		22EE673	Clubs- Social, Cultural & Academic	Coordinators								
8	PCCL	22EEL68	Advanced C with C++ Lab	EE	0	0	2	02	1	50	50	100
Total									**18**	**750**	**450**	**1200**

Professional Elective Course

22EEPE631	HVDC Power Transmission	22EEPE634	Embedded Systems
22EEPE632	Signals, Systems & Processing	22EEPE635	Electric Vehicle Technology (2-0-2)
22EEPE633	Electrical Energy Conservation & Auditing		

Open Elective Course

22MAT641	Linear Algebra	22EEOE645	Fuzzy Logic and applications
22MAT642	Applied Statistics	22EEOE646	Renewable Energy Sources
22CH643	Nano Science & Nano Technology	22EEOE647	Energy Storage Systems
22MBA64	Marketing Management	22EEOE648	PLC & Industrial Automation

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23 **National Service Scheme /Physical Education/Yoga/Clubs:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga(YOG) and Clubs with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Club activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.
Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.
Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.
Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

KLS Gogte Institute of Technology

4thYear B.E. Scheme of Teaching and Examination 2022

7th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	IPCC	22EE71	Computer Applications in Power System Analysis	EE	3	0	2	05	4	100	100	200
2	PCC	22EE72	Power System Protection & High Voltage Engineering	EE	3	0	0	03	3	100	100	200
3	PCC	22EE73	Electrical Drives & Traction	EE	4	0	0	04	4	100	100	200
4	PEC	22EE74X	**Professional Elective Course**	EE	3	0	0	03	3	100	100	200
5	OEC	22EE75X	**Open Elective Course**	EE	3	0	0	03	3	100	100	200
6	PROJ	22EE76	**Major Project Phase-II**		0	0	10	10	5	100	100	200
7	AEC	22AECEE77	Indian Knowledge System		1	0	0	01	1	100	-	100
8	PCCL	22EEL78	Relay and High Voltage Lab	EE	0	0	2	02	1	50	50	100
Total									**24**	**750**	**650**	**1400**

Professional Elective Course			
22EEPE741	Testing & Commissioning of Electrical Equipment	22EEPE744	Smart Grids
22EEPE742	FACTS	22EEPE745	Modern Control Theory
22EEPE743	Special Electrical Machines		

Open Elective Course			
22MAT751	Optimization Techniques	22EEOE755	Electrical Energy Conservation & Auditing
22MAT752	Complex Analysis & Special Functions	22EEOE756	Solar & Wind Energy
22PHY753	Introduction to Astronomy	22EEOE757	Electric Vehicles
22MBA754	Human Resource Management for Engineers	22EEOE758	IoT& Data Analytics

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK: The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the COE. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

IKS (Indian Knowledge system) - VTU in compliance with UGC directive has introduced **IKS (Indian Knowledge system)** in the 6thsem as AEC (1 credit) for 2022 scheme. Hence after discussion it has been decided to introduce the IKS course (as 1 credit) in the 7thsem as an AEC.

Online courses in 8th sem (OEC & PEC)- OEC & PEC courses present in the 8th sem should be completed by the end of 7th semester & valid Certificates by Competent authority to be submitted to the Department. These are ONLINE courses suggested by the respective Board of Studies. The online courses can be NPTEL/SWAYAM/NASSCOM/Industry/VTU certified and for a minimum duration of 12 weeks. Details of these courses shall be made available for students on the college web portal.

8th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	PEC	22EEPE81X	Professional Elective (Online Courses)	TD- PSB:	3	0	0	03	3	100	-	100
2	OEC	22EEOE82X	Open Elective (Online Courses)	TD: PSB:	3	0	0	03	3	100	-	100
3	INT	22EE83	Internship (Industry/Research) (14 - 20 weeks)	TD: PSB:	0	0	20	20	10	100	100	200
Total									**16**	**300**	**100**	**400**

Professional Elective Course (Online courses)			
Code1	Power Systems a) https://online.vtu.ac.in/course-details/Smart-Grid-Basics-To-Advanced-Technologies b) https://onlinecourses.nptel.ac.in/noc24_ee141/preview	Code3	Electric & Hybrid Vehicles https://onlinecourses.nptel.ac.in/noc24_ee133
Code2	Renewable Energy Sources https://onlinecourses.nptel.ac.in/noc24_ee109/	Code4	Embedded System Design https://online.vtu.ac.in/course-details/introduction-to-embedded-system-design
Code3	Electrical Machines https://onlinecourses.swayam2.ac.in/nou24_ee01/preview	Code 6	Microelectronics https://online.vtu.ac.in/course-details/Microelectronics-Devices-To-Circuits
Open Elective Courses (Online Courses)			
Code1	Digital Image Processing https://onlinecourses.nptel.ac.in/noc24_ee133/preview	Code3	Industrial Automation https://onlinecourses.swayam2.ac.in/nou24_ee02/
Code2	Artificial Intelligence & Machine Learning https://online.vtu.ac.in/course-details/Introduction-to-Machine-Learning-12-weeks	Code4	Cloud Computing https://onlinecourses.nptel.ac.in/noc24_cs118/preview
Code5	Cyber Security https://onlinecourses.swayam2.ac.in/nou24_ge65/	Code 6	Programming Languages https://onlinecourses.nptel.ac.in/noc24_cs125

L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship

Note: VII and VIII semesters of IV years of the program

Swapping Facility

- Institution can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ industry internships/Rural Internship** after the VI semester**.**
- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment. The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **College shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. The online courses can be NPTEL/SWAYAM/NASSCOM/Industry/VTU certified and for a **duration of 12 weeks**. Details of these courses shall be made available for students on the college web portal.

5TH SEMESTER

INDUSTRIAL MANAGEMENT, ELECTRICAL ESTIMATION & COSTING

Course Code	22EE51	**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.	To understand the characteristics of management, role of management, importance and purpose of planning, organizing, staffing, directing and controlling
2.	To understand the meaning of innovation, creativity, entrepreneur, entrepreneurship, creative problem solving techniques
3.	To 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 : Universal human values course, Basic electrical engineering

Unit – I	**Contact Hours = 8 Hours**
Management: Introduction, nature and characteristics of management, scope and functional areas of management, management is science or an art. **Planning:** Nature, importance and purpose of planning process, types of plans, 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: 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 sound 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, barriers in entrepreneurship. **Creativity and Innovation:** Creativity, source of new Idea, ideas into opportunities, creative problem solving: heuristics, brainstorming, synectics, significance of intellectual property rights	

Unit – IV	Contact Hours = 8 Hours
Introduction to estimation & costing: Purpose of estimating and costing, electrical schedule, catalogues, market survey and source selection, recording of estimates, determination of required quantity of material, labor conditions, determination of cost, material and labor, contingencies, overhead charges, profit, purchase system, statement, purchase orders **Internal wiring circuit & I.E. Rules:** Distribution of electrical energy, types of drawing: Electrical layout, wiring diagram, schematic diagram, single line diagram, simple light and fan circuits, types and design of lighting schemes, general idea about IE rule, Indian electricity act and major applicable I.E rules.	

Unit – V	Contact Hours = 8 Hours
Residential Wiring System: General rules for wiring, determination of number of points (Light, Fan, Socket outlets), determination of total load, determination of number of sub circuits, determination of rating of main switch and distribution board, determination of size of conductor, determination of length of conduit **Selection & Calculation:** Selection of type of electrical accessories, earthing of residential installation, sequence to be followed for preparing estimate, design of the residential wiring system, preparation of detailed estimates and costing of residential installation, design of a main panel of a residential building/commercial workshop, illustrative examples of residential building wiring, estimation and costing.	

Flipped Classroom Details

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

Books	
	Text Books:
1.	Henry Koontz : "Essentials of Management" Latest Edition
2.	Poornima.M.Charantimath : Entrepreneurship Development – Pearson Education – 2014 Edition
3.	J.B.Gupta, "Electrical Installation Estimating & Costing" VIII Edition S.K. Kataria & Sons New Delhi,
4.	K.B.Raina S.K.Bhattacharya, "Electrical Design Estimating and Costing", New Age International publications,
5.	Surjit singh, "Electrical Estimating and Costing", Dhapat Rai & Co , 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
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the scope and ***apply*** the function of management.	An	1,9,10 ,12	4
2.	***Explain*** the characteristics and process of entrepreneurship.	Un	1,9,10 ,12	4
3.	***Design and estimate*** the wiring and lighting scheme for residential and commercial applications.	Ev	1,11,1 2	2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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	✓								✓	✓	✓	✓		✓		

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 and administrative skill	Self-employment/All industries	Entrepreneur, manager, engineer, team lead
2	Design and Estimation skill	Self-employment/All industries	Design and installation engineer, Contractor

Name & Signature of Faculty members members involved in designing the syllabus

Name & Signature of Faculty verifying/approving the syllabus

OPERATIONAL AMPLIFIER AND APPLICATIONS

Course Code	22EE52	Course type	IPCC	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 and its 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 Introduction to Integrated Circuits, 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.	

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:** Functional diagram of 555 Timer, modes of operation.	

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

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	Direct coupled and capacitor coupled non-inverting amplifier using 741 Op amp (Simulation/Hardware)
2	1	Non Saturating Precision full wave rectifierusing 741 Op amp (Simulation/Hardware)
2	1	Precision Clippers /Clampers circuits using 741 Op amp
3	1	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	Square wave generator/ triangular wave generator using 741 Op-amp (Simulation/Hardware)
5	1	Wein bridge oscillator using 741Op-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:
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.	Lab Test
3.	Flipped Classes	3.	Semester End Examination
4.	Practice session/Demonstrations in Labs		
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
2.	***Analyze/ Design*** the circuit models of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, filters, oscillators, timers etc.	Ap-An	1 2,5,9,10,12	1,3
3.	***Develop/Demonstrate*** the circuit models of OP-AMP applications namely amplifiers, Signal processing circuits, switching circuits, filters, oscillators, timers etc.	Ap-An	1,2,5,9,10,12	1,3

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	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive.				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise 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: 15 marks 5. Viva voce: 10 marks				
Eligibility for SEE: 1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE** 2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.** 3. Lab test is COMPULSORY 4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.** 5. 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 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping(planned)			
C O	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.		

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

CONTROL SYSTEMS

Course Code	22EE53	Course type	PCC	Credits L-T-P	4 – 0 - 0
Hours/week: L - T- P	4 – 0 – 0			Total credits	4
Total Contact Hours	L = 50 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 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 analyse 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 = 10 Hours
Modelling 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 = 10 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 = 10 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. Root locus using MATLAB**	

Unit – IV	Contact Hours = 10 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 **Bode plots:** Assessment of stability from Bode plot. Bode plot using MATLAB	

Unit – V	Contact Hours = 10 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

Unit No.	Self-Study Topics
III	Root locus using MATLAB.
IV	Bode plot using MATLAB.

Books	
	Text Books:
1.	R Ananda Natarajan, P Ramesh Babu**Control System Engineering,**2006 Scitech Publications (India) PVT Ltd.
2.	D Ganesh Rao, K ChannaVenkatesh, **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.
2.	Norman S Nise, **Control Systems Engineering**, ,Wiley Student Edition,5th Edition.
	E-resources (NPTEL/SWAYAM.)
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.	Assignment- Open/Industry/Certification
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.	***Explain*** control systems and basic terminology related to time response and frequency response	Un	1,12	1,2
2.	***Apply*** the transfer function methods to build the model of the given system	Ap	1	1,2
3.	***Determine*** **and** ***analyse*** the different parameters related to stability using time response and frequency response methods.	An	1,2,5	1,2
4.	***Design*** different compensators and controllers for different applications and analyse the performance.	An	1,2,5	1,2

Scheme of Continuous Internal Evaluation (CIE) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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	System Modelling,	Automobile, hardware, R&D etc	Design Engineer, Control engineer
2	Stability assessment		

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

FUZZY LOGIC AND APPLICATIONS

Course Code	22EEPE541	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	3 Hours			SEE Marks	100

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

Pre-requisites : Classical 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, aircraft landing Control, speed control of DC motor, 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	1	-	-	1	1

Unit No.	Self-Study Topics
1	Classical set theory

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
1.	https://nptel.ac.in/courses/108104157

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Explain*** the basic concepts of fuzzy sets, operations, properties of fuzzy sets, fuzzy relations, basic features of membership functions, fuzzification ,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) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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%.
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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	✓	✓	✓		✓				✓	✓			✓	✓		
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, power systems	R&D Engineer, system engineering

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

PLC and Industrial Automation

Course Code	22EEPE542	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 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 understand and demonstrate instruction lists, sequential function charts & structured text, and subroutines**.**
4.	To demonstrate Ladder programs and control relay.
5.	To understand and demonstrate different types of timers and counters, programming with timers and counters.

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

Unit – I	**Contact Hours = 8 Hours**
INTRODUCTION TO PLC: 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, I/O units, signal conditioning, remote connections, networks, processing inputs I/O addresses.	

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

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

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

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

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
2.	**Programmable Controllers, An Engineers Guide**-E. A Paar, newness, 3rd edition, 2003.
	E-resources
1.	https://nptel.ac.in/courses/108105063

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***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 and make use of*** instruction list, sequential functions charts & structured text, subroutines**.**	Un,Ap	1,2,3,4,5,6	1,2,3
4.	***Develop and analyze*** 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) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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	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

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

RENEWABLE ENERGY SOURCES

Course Code	22EEPE543	**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	5 Hours			**SEE Marks**	100

Course learning objectives	
1	To understand the energy scenario of the world
2	To understand the solar geometry and its use in renewable energy analysis.
3	To explain the energy generation from solar thermal and photovoltaic systems.
4	To explain the concept of energy conversion process from biomass and construction of different biomass plants.
5	To understand the fundamentals of energy generation from wind source.
6	To understand the fundamentals of batteries, fuel cells and its use in industrial and commercial contexts

Pre-requisites : Basic Electricals, Energy sources

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;	

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, numerical problems.	

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.	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Per capita energy consumption
2	Domestic lighting
3	Biomass program in India
4	Wind energy scenario – World and India
5	Emerging trends in batteries

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:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the renewable energy concept, battery technology and fuel cell.	Un	1,6,7,9,10,11,12	1,2,4
2.	***Illustrate*** the power generation by various renewable energy sources	Un	1,6,7,9,10,11,12	1,2,4
3.	***Plan*** Solar & Wind energy systems	Ap	1,3,6,7,9,10,11,12	1,2,4

Scheme of Continuous Internal Evaluation (CIE) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	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 & wind energy systems	Solar & Wind Power industry	Design/Site Engineer
2	Concept of fuel cells	R&D in energy sector	R&D Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ADVANCED POWER ELECTRONICS

Course Code	22EEPE544	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 and analyze the operation of various switched mode dc-dc converters.
2.	To understand and analyze the operation of dc-dc converters with isolation for power supply applications.
3.	To understand principles of design of high frequency inductor and transformers
4.	To understand and explain the operation of resonant converters.
5.	To understand the application of power electronics to battery management systems.

Prerequisites: Power Electronics

Unit – I	Contact Hours = 8 Hours
Switched mode DC-DC converters-I: 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-II: 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- different passive and active balancing techniques, 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:
1.	https://nptel.ac.in/courses/108108036

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	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.	***Analyze*** the operation of different types 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 dc-dc converters for power supply applications and determine the circuit parameters	An	1, 2, 4, 10, 12	1,3
3.	***Explain*** the high frequency inductor and transformer design for power electronic systems	Un	1, 12	1,3
4.	***Explain*** the 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) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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**
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

Name & signature of Faculty members involved in designing the syllabus

Name & signature of Faculty members verifying/approving the syllabus

ENERGY STORAGE SYSTEMS

Course Code	22EEPE545	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 the principles of design and operation of battery/storage technology systems
2.	To analyze and evaluate different battery technologies available in the market
3.	To design and develop energy storage solutions using battery technology
4.	To understand the impact of battery technology on the environment and society

Pre-requisites : Basics cell chemistry.

Unit – I	Contact Hours = 8 Hours
ENERGY STORAGE: Necessity of energy storage, battery basics, introduction to electric vehicle batteries, fuel cell technology, choice of a battery type for electric vehicles	

Unit – II	Contact Hours = 8 Hours
ELECTROCHEMICAL BATTERY: electrochemical batteries, electrochemical reactions, states of the battery, thermodynamic voltage, specific energy, specific power, and energy efficiency	

Unit – III	Contact Hours = 8 Hours
MODERN STORAGE SYSTEMS: **Ultracapacitors**: Features, basic principle, performance, ultra-capacitors technology, advanced materials and technologies for super-capacitors **flywheels**: principle of operation, power capacity, flywheel technology	

Unit – IV	Contact Hours = 8 Hours
Lithium Ion Battery: Principle of operation, lithium-metal polymer batteries, li – air batteries, li – sulphur batteries, li resources and recycling of li-ion batteries	

Unit – V	Contact Hours = 8 Hours
Hybrid Energy Storage: Concept of hybrid energy storage, passive and active hybrid energy storage with batteries & ultra-capacitors, applications of energy storage systems, ups, battery bank systems, and electric vehicles, hydrogen storage systems and modern trends in energy storage	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Choice of a Battery Type for Electric Vehicles
2	Electrochemical reactions
3	Advanced materials and technologies for super-capacitors
4	Li resources and recycling of Li-ion batteries

Books	
	Text Books:
1.	Bruno Scrosati, Jürgen Garche, Werner Tillmetz, "Advances in Battery Technologies for Electric Vehicles", Woodhead Publishing Series in Energy, 1st Edition, 2015.
2.	Christian Glaize, Sylvie Genies, "Lithium Batteries and other Electrochemical Storage Systems", Wiley-ISTE, July 2013.
	Reference Books:
1.	MehrdadEhsani , Yimin Gao, Stefano Longo, KambizEbrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2018
	E-resources:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the necessity of Energy Storage system	Un	1, 6, 7,10	1
2.	***Explain*** the construction & operation of different types of batteries	Un	1, 6, 7,10,12	1, 2
3.	***Explain*** the Integration with Renewable Energy, Economic and Environmental Impact	Un	1, 6, 7,10, 12	1, 2
4.	***Explain*** the applications of various types of batteries	Un	1, 6, 7, 12	1, 2

Scheme of Continuous Internal Evaluation (CIE) for Theory course

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Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
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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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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																

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

RESEARCH METHODOLOGY AND IPR

Course Code	22EE56	Course type	AEC	Credits L-T-P	2-0-0
Hours/week: L-T-P	2-0-0			Total credits	2
Total Contact Hours	L = 30 Hrs; Total = 30 Hrs			CIE Marks	100
Flipped Classes content	05 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the basic concepts of research and its methodologies
2.	Identify and select the appropriate research.
3.	Understand the basic concepts & types of hypothesis.
4.	Create the awareness about Intellectual Property Rights for the protection of inventions.

Required Knowledge of : --

Unit – I	Contact Hours = 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.

Unit – II	Contact Hours = 6 Hours

Research Problem: Defining a research problem, selecting a research problem, necessity and techniques involved in defining the research problem.

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

Unit – III	Contact Hours = 9 Hours

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.

Testing of hypothesis 1

Definition, basic concepts, procedure, flow diagram, measuring the power of hypothesis tests, tests of hypothesis.

Chi-square test

Chi-square as a test for comparing variance, steps involved in applying chi-square test.

Unit – IV	Contact Hours = 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, Prior art search.	

Unit – V	Contact Hours = 5 Hours
Interpretation and Report Writing: Meaning of interpretation, Why interpretation, Technique of interpretation, Precaution in interpretation, Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Mechanics of writing research report.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	01	01	01	01	01

Unit No.	Self-Study Topics [Mention if applicable else NIL]
1	Significance of Research Methodology.
2	Limitations of test of hypothesis.
3	Other measures-Index numbers, Time series analysis.

	Books
	Text Books:
1.	C R. Kothari, **"Research Methodology"**, New Age International Publishers, 2nd edition, 2007.
2.	Dr. B.L. Wadhera, **"Intellectual Property Rights"**, Universal Law Publishing Co. Ltd.. 2002
	Reference Books:
1.	PanneerSelvam, **"Research Methodology"**, PHI Learning Pvt. Ltd., 2007.
	E-resources (NPTEL/SWAYAM.. Any Other)-
1.	https://onlinecourses.swayam2.ac.in/cec20_ge37

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Assignments (OA)
3.	Flipped Classes	3.	Case studies
4.		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.	***Identify and select*** an appropriate methodology for research.	**Un**	**1,2,9,10**	**1**
2.	***Analyse*** and interpret data collected	**Ap**	**1,2,9,10**	**1**
3.	***Analyse*** the significance of hypothesis testing	**An**	**1,2,9,10**	**1**
4.	Discuss the significance of Intellectual Property Rights & report writing	**Ap**	**1,2,3,9,10,12**	**1,2,3**

Scheme of Continuous Internal Evaluation (CIE) for Theory course

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**		
CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	✓	✓							✓	✓			✓		
2	✓	✓							✓	✓			✓		
3	✓	✓							✓	✓			✓		
4	✓	✓	✓						✓	✓		✓	✓	✓	✓

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 and analyzing energy storage technologies	Renewable Energy and Utilities	Energy Storage Engineer
2	Installing, maintaining, and optimizing energy storage systems	Electric Vehicles and Industrial Applications	Renewable Energy Specialist, Grid Analyst, Project Manager, Research Scientist
3	Managing projects, ensuring compliance, and effective stakeholder communication	Residential and Research	Energy Consultant, Product Manager

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

Employability Skills I

Course Code	22EE57	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 = 30 Hrs; T = 0 Hrs; P = 0 Hrs Total = 30 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 = 6 Hours
***Quantitative Aptitude*:** Number System (2 Hours), HCF, LCM and Decimal Fractions (1 Hour), Simplification (1 Hour) ***Logical Reasoning*:** Blood Relations (1 Hour), Direction Sense Test (1 Hour)	

Unit – II	Contact Hours = 6 Hours
Quantitative Aptitude*:** Percentages (2 Hours), Profit, Loss and Discounts (2 Hours) ***Verbal Ability: Change of Speech and Voice (2 Hours)	

Unit – III	Contact Hours = 6 Hours
Quantitative Aptitude*:** Simple and Compound Interest (2 Hours) ***Logical Reasoning*:** Number and Letter Series (2 Hours) ***Verbal Ability: Sentence Correction (2 Hours)	

Unit – IV	Contact Hours = 6 Hours
***Quantitative Aptitude*:** Averages (2 Hours) ***Logical Reasoning*:** Coding and Decoding (1 Hour), Analogy (1 Hour) ***Soft Skills*:** Body Language (1 Hour), Grooming and Etiquette (1 Hour)	

Unit – V	Contact Hours = 6 Hours
Quantitative Aptitude: Alligations and Mixtures (2 Hours) ***Verbal Ability*:** Sentence Completion (2 Hours) ***Soft Skills*:** Group Discussion and Mock GDs (2 Hours)	

Books	
	Text Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	The Aptitude Triad , BIZOTIC
2.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.
3.	How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.

4.	How to prepare for Verbal Ability and Reading Comprehension for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
5.	How to prepare for Data Interpretation for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 5th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes
		3.	Assignments
		4.	Seminar

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, 12	
2.	Perform confidently during the GD and Interview process	L2	10, 12	
3.	Develop behaviors that are appropriate for a professional	L2	10, 12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two Assignments	Total Marks
Marks	30+30 = 60	20	10+10 =20	100
- Writing 2 IA tests are compulsory **-Student should score minimum 40% of 100 marks to pass the course.**				

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**	**IT Industry**	**Software Engineer**
2	**Problem Solving**	**Automotive**	**Developer**
3	**Communication Skills**	**Education Sector**	**Project Manager**

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

Environmental Studies

Course Code	22EE58	Course type	HSMS	Credits L-T-P	2-0-0
Hours/week: L-T-P	2-0-0			Total credits	2
Total Contact Hours	L = 30 Hrs; Total = 30 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

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

Required Knowledge of : Nil

Unit – I	Contact Hours = 6 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 = 6 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 = 6 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 = 6 Hours
Disaster Management: International strategy for disaster reduction. Concept of disaster management and national disaster management framework.	

Unit – V	Contact Hours = 6 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	1	1	1	1	1

Unit No.	Self-Study Topics [Mention if applicable else NIL]

Books	
	Text Books:
1.	Benny Joseph, **"Environmental Studies"**, Tata McGraw – Hill Publishing Company Limited (2005).
2.	Sanjay K. Sharma, **"Environment Engineering and Disaster Management"**, USP (2011).
3.	Harsh K. Gupta, **"Disaster Management"**, Universities Press (India) Pvt. Ltd (2003).
4.	Ranjit Daniels R.J. and JagdishKrishnaswamy, **"Environmental Studies"**, Wiley India Private Ltd., New Delhi (2009).
	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).

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	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.	Understand the importance of the Environment and different sources of energy and energy crises.	Un	**6,7**	**1**
2.	Understand various environmental disasters and its management.	Ap	**6,7**	**1**
3.	Understand the various Legislations related to Environment.	Un	**6,7**	**1**

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping(planned)		
CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO 1**	**PSO 2**	**PSO 3**
1						√	√						√		
2						√	√						√		
3						√	√						√		

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ELECTRICAL AND ELECTRONICS MEASUREMENT LAB

Course Code	22EEL59	Course type	PCCL	Credits L-T-P	0 - 0 - 1
Hours/week: L - T- P	0 - 0 - 2			Total credits	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			CIE Marks	50
Flipped Classes content	-			SEE Marks	50

Course learning objectives	
1.	To determine unknown inductance, resistance by using various bridges.
2.	To measure the physical parameters using sensors and transducers.
3.	To utilize appropriate instruments to measure given set of parameters.

Required Knowledge of: Basics of Electrical Engineering, Electrical Parameters

Lab Experiment – I	Contact Hours = 2 Hours
Measurement of low resistance using Kelvin's Double Bridge	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Measurement of inductance using Maxwell's LC Bridge	
Lab Experiment – 3	**Contact Hours = 2 Hours**
Measurement of Earth resistance using earth tester	
Lab Experiment – 4	**Contact Hours = 2 Hours**
Extension of ammeter range using shunt	
Lab Experiment – 5	**Contact Hours = 2 Hours**
Extension of voltmeter range using multiplier	
Lab Experiment – 6	**Contact Hours = 2 Hours**
Measurement of temperature using thermocouple	
Lab Experiment – 7	**Contact Hours = 2 Hours**
Measurement of core displacement using linear variable differential transformer	
Lab Experiment – 8	**Contact Hours = 2 Hours**
Determination of Young's modulus of elasticity of a mild steel specimen using strain gauge	

Books	
	Text Books:
1.	Electrical and Electronic Measurements and Instrumentation, Er. R K Rajput, ISBN : 9789385676017,
2.	Electrical and Electronic Measurements and Instrumentation, S K Bhattacharya & S Bhattacharya, Vikas Publishing, ISBN: 9789325994010,
	Reference Book:
1.	A Course in Electrical and Electronic Measurements and Instrumentation | A.K. SAWHNEY | DHANPAT RAI, ISBN 13, Publisher: Dhanpat Rai, Edition: 19th ,

Course delivery methods		Assessment methods	
1.	Practice sessions/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/Open-ended experiment
4.		4.	Lab Test
5.		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.	***Use*** measuring devices and sensors to measure resistance, inductance and other physical parameters.	Ap	1,9,5,10,12	2,3
2.	***Analyze*** the readings and results obtained from various electrical measuring circuits	An	1,5,9,10,12	2,3
3.	***Interpret*** the results obtained using various devices.	Ev	1,5,9,10,12	2,3

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva voce	Journal	Lab project/open-ended expt.	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

1. Conduction of the experiment: 15 marks + Viva voce: 5 marks
2. Calculations, results, graph, conclusion, and Outcome recorded in Journal: 5 marks
3. Lab project/ Open-ended experiment: 10 marks
4. Lab Test: 15 marks

Eligibility for SEE:

1. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** The score should be ≥35%, however, the overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments are to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results, and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva voce shall be conducted for individual students and not in a group.		

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	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	Technical Proficiency and Analytical Skills	Electronics and Semiconductor Industry, Automotive Industry	Electronics Engineer, Power Systems Engineer, Automation Engineer
2	Computational Skills	Power and Energy Sector, Aerospace and Defense	Test Engineer, Manufacturing Engineer
3	Safety and Compliance	Healthcare and Medical Devices, Industrial Automation and Robotics, Consumer Electronics, Manufacturing	Embedded Systems Engineer

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6TH SEMESTER

IOT AND DATA ACQUISITION

Course Code	22EE61	Course type	IPCC	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 basic principles of IoT, digitization and different IoT architectures.
2.	To understand and explain the smart objects, application of IoT in different industries.
3.	To understand, explain and apply Data and Analytics for IoT, IoT Physical Devices.
4.	To 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 OT, 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: 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 and agriculture.	

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, end device activation methods, activation by personalising (ABP) method and Over the air activation method (OTAA), 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, introduction to data analytics using machine learning.

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 end points. **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	**2**	Blinky Programming using Arduino UNO:
5		String display RaspberryPi
1 & 2	**5**	Real-time monitoring and measurement of weather data
1 & 2		Relay based real-time control of electrical equipment's.
1 & 2		Water level monitoring with buzzer
1 & 2		Automatic temperature controlling system
1 & 2		Flame detection and alerting system
4	**2**	Cloud connectivity
4		Data analytics using machine learning.

Unit No.	**Self-Study Topics**
3	End device activation methods, activation by personalising (ABP) method and Over the air activation method (OTAA)

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.
3.	Pradeeka Seneviratne, "Beginning LoRa Radio Networks with Arduino", APRESS.
	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
1.	https://onlinecourses.nptel.ac.in/noc24_cs115/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Lab Test
3.	Flipped Classes	3.	Semester End Examination
4.	Practice session/Demonstrations in Labs		
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	1,2,5,9, 10	3
2.	**Explain** the smart objects, application of IoT in industries.	Un	2,4,5,9, 10,12	3
3.	**Explain** and **analyze** Data and Analytics for IoT, IoT Physical Devices	An	2,4,5,9, 10,12	3
4.	**Design** and **analyze** different IoT platforms.	An	2,4,5,9, 10,12	3

Scheme of Continuous Internal Evaluation (CIE) for Integrated course:

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	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive.				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise 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: 15 marks 5. Viva voce: 10 marks				
Eligibility for SEE: 1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE** 2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.** 3. Lab test is COMPULSORY 4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.** 5. 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 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	Coding, Data structure handling Soft skill, managerial skill, etc	IT sector	Team Lead
2		Core companies	Developer, Project manager
3		Self-employment (Startup)	Entrepreneur

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

POWER SYSTEM ANALYSIS

Course Code	22EE62	Course type	PCC	Credits L-T-P	4 – 0 - 0
Hours/week: L - T- P	4 – 0 – 0			Total credits	4
Total Contact Hours	L = 50 Hrs; T = 0 Hrs; P = 0 Hrs Total = 50 Hrs			CIE Ma rks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the modelling and representation of single line diagrams of power systems.
2.	To understand and analyze symmetrical faults, transients in power systems and selection of circuit breakers.
3.	To understand and analyze the unsymmetrical faults in a power system using symmetrical components
4.	To understand the power system stability and its implications.

Pre-requisites : Electrical machines, Power transmission & distribution

Unit – I: Representation of power system components	Contact Hours = 10 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 = 10 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 = 10 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 = 10 Hours
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 = 10 Hours
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

Unit No.	Self-Study Topics
1.	**Circuit Models**
2.	**Rating & Selection of Circuit Breakers**
3.	**Measurement of Sequence Impedances**
5.	**Applications of Equal Area Criterion**

	Books
	Text Books:
1.	I. J. Nagrath and D.P.Kothari, **"Modern Power System Analysis",** TMH, 3rd Edition, 2003.
2.	W.D.Stevenson, **"Elements of Power System Analysis",** TMH,4th edition
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 systems",** New Age publications, 4th Edition
	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.	Assignment- Open/Industry/Certification
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.	***Make use of*** single line line diagrams and impedance diagrams to represent the power systems	Ap	1,10,12	1,2
2.	***Explain*** and ***analyze*** balanced and unbalanced systems, transients in power systems, symmetrical and unsymmetrical faults using symmetrical components and sequence networks	An	1,10,12	1,2
3.	***Explain*** and ***analyze*** steady state and transient state stability of power systems using swing equation and equal area Criterion	An	1,10,12	1,2
4.	***Determine*** short circuit fault current, short circuit MVA and ***select*** the circuit breakers.	Ap	1,10,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	Modeling & analysis of Power Systems	Power Systems, Core Industries	Power System Engineer, Design Engineer, Lead Electrical Engineer, Entrepreneur

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

HVDC POWER TRANSMISSION

Course Code	22EEPE631	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 know** the fundamental concepts underlying HVDC transmission
2.	**To study** the operation of HVDC systems, MTDC systems, parallel AC/DC systems and current control mechanisms
3.	**To know** the control strategies employed in HVDC systems
4.	**To study** harmonic sources and filters

Prerequisites : Power electronics, power systems

Unit – I	Contact Hours = 8 Hours
Development of HVDC transmission – Historical development, equipment required for HVDC systems, Comparison of AC and DC transmission, Limitations of HVDC transmission, Reliability of HVDC systems, Standard rated voltages of HVDC and EHVAC systems, choice of EHVAC and UHVAC lines and substation, Comparison of HVDC link with EHVAC link, concept of HVDC- VSC transmission systems	

Unit – II	Contact Hours = 8 Hours
HVDC converter operation and analysis – SCR and IGBTs, HVDC converter valves and valve assembly, Principle and operation of HVDC voltage source converters, three phase six pulse converters using SCRs, Concept of 12 pulse bridge converters, Conduction sequence in 6 pulse converter configuration, Ideal commutation process without gate control, concept of overlap angle, Equivalent circuit of converter with overlap, AC current waveform in 12 pulse converter (No derivation)	

Unit – III	Contact Hours = 8 Hours
Control of HVDC converter and systems – Mechanism of AC power transmission, Principle of control, Necessity of control in case of a DC link, Rectifier control, compounding of rectifiers, Power reversal in a DC link, VDCOL characteristics of converter, System control hierarchy, Inverter extinction angle control, pulse phase control, Starting and stopping of DC link (No derivation)	

Unit – IV	Contact Hours = 8 Hours
Reactive power control and Harmonic suppression – Importance of harmonic study, Generation of harmonics by converters, Characteristic harmonics on DC side, Characteristic current harmonics and variation with trigger angle and overlap angle, Effect of control modes on harmonics, Noncharacteristic harmonics, Harmonics in VSC converters, Use of filters, Filter configuration, Concept of DC filters **,** Concept of reactive power control	

Unit – V	Contact Hours = 8 Hours
Multiterminal HVDC systems and parallel AC/DC systems – Types of MTDC systems, control of power in MTDC systems, Power transfer capabilities and reliability conditions in parallel AC/DC systems, Power loss considerations and other technical aspects, Environmental considerations for DC transmission, Power upgrading and conversion of AC lines into DC lines, Modeling of HVDC systems	

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 Kamakshaiah, V Kamaraju, HVDC transmission, Tata McGrawhill Education Private Limited, 2011
2.	Kimbark E. W., Direct current transmission, Wiley Interscience (New York), 1971
	Reference Books:
1.	K. R. Padiyar, HVDC power transmission systems technology and system interactions, New age international (P) limited, publishers, New Delhi, 2007
2.	Vijay K Sood, HVDC and FACTS controllers, Kluwer academic publishers, 2013
3.	Arillaga J., High voltage direct current transmission, (London) Peter Peregrinus, 1983
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
	https://archive.nptel.ac.in/courses/108/104/108104013/108104013

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Compare and contrast*** HVDC transmission with traditional AC transmission, assessing their respective advantages, limitations, and suitability for different applications and operating conditions.	An	1,7,10,12	1,2
2.	***Analyse*** the components and operation of HVDC systems, including converters, transformers, filters, and control systems, to comprehend their roles and interactions in achieving efficient power transmission.	An	1,7,10,12	1,2,3
3.	***Explain*** the fundamental principles governing HVDC transmission, including the concept of direct current transmission, converter technologies, and key components of HVDC systems.	Un	1,7,10,12	1,2
4.	***Analyse*** the performance of HVDC system after connecting harmonic filter	An	1,2,10,12	1,2
5.	***Explain*** MTDC systems and simulation tools used for HVDC transmission	Un	1,9,10,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	✓	✓								✓		✓	✓	✓		
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 criteria for HVAC and HVDC systems, Design of harmonic filters	Power system transmission and distribution, Grid control	Power system engineer, consultant, Design engineer
2	Modification of existing HVAC line into DC line	Power system transmission and distribution, Grid control	Power system engineer, consultant, Design engineer
3	Simulation of HVDC systems	Power system transmission and distribution, Grid control	Power system engineer, consultant, Design engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

SIGNALS, SYSTEMS AND PROCESSING

Course Code	22EEPE632	**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	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the basics of signals and systems and analyze the system responses
2.	To analyze the concept and applications of Z transform and Discrete Fourier Transform (DFT)
3.	To analyze and design IIR and FIR filters
4.	To understand and analyze FFT algorithm

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

Unit – I	**Contact Hours = 8 Hours**

Basics 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- Convolution, Impulse response, properties, solution of differential and difference equations.

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.

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	1	2	0	2	0

Unit No.	Self-Study Topics
2	Z-transform by partial fraction expansion method.
4	Overlap save method for fast convolution

Books	
	Text Books:
1.	Signals and Systems- Simon Haykin and Barry Van Veen, John Wiley & Sons Publishers, Second edition,2007 onwards.
2.	Digital Signal Processing Principle, Algorithm & application, John G Proakis, Dimitris G. Manolakis, Pearson Publishers, Fourth edition,2007 onwards.
3.	Signals and Systems, Udaykumar Pristine publishing house, Seventh edition-2018 onwards.
	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.
	E-resources:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the basics of signals and systems and analyze the system responses	Un	1,2,12	1,3
2.	***Explain and apply*** Z transform and Discrete Fourier Transform (DFT)	Ap	2,12	1,3
3.	***Design and analyze*** IIR and FIR digital systems	An	2,12	1,3
4.	***Explain and analyze*** FFT algorithm.	An	2,12	1,3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	Design and analysis of communication systems	Biomedical Engineering, medical imaging, and autonomous systems	Telecommunications, Signal Processing, Embedded Systems, Electronics Design Engineer Data Scientist
2	Processing of the signals	Wireless communication	
3	Design of analog and digital filters	Robotics and automotive engineering	

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ELECTRICAL ENERGY CONSERVATION AND AUDITING

Course Code	22EEPE633	**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	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the concepts of energy scenario and energy conservation ACT-2001.
2.	To understand the concepts of energy management and audit.
3.	To understand the theory of energy efficiency in electrical systems.
4.	To understand the energy efficient technologies in electrical system.

Pre-requisites : Basics of electrical engineering and power system.

Unit – I	Contact Hours = 8 Hours

Energy Scenario: Renewable and non-renewable energy, Indian energy scenario, integrated energy policy, energy intensity on purchasing power parity, Energy sector reforms, energy and environment, energy security, energy conservation and its importance, Energy Conservation Act-2001 and its features.

Unit – II	**Contact Hours = 8 Hours**

Energy Management & Audit: Definition, energy audit, need, types of energy audit and approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

Unit – III	**Contact Hours = 8 Hours**

Energy efficiency in Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement benefits, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.

Electric motors: motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Unit – IV	**Contact Hours = 8 Hours**

Fans and blowers: Types, performance evaluation, efficient pumping system operation, flow control strategies and energy conservation opportunities.

Lighting System: Introduction, Basic Parameters and terms in lighting system, Lighting source and lamp types, recommend illuminance levels for various tasks/activities/locations, methods of calculating illuminance-lighting design for interiors, general energy saving opportunities, energy efficient lighting controls standard and labeling programs for FTL lamps and lighting case study.

Unit – V	Contact Hours = 8 Hours
Energy Efficient Technologies: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Renewable and non-renewable energy, Indian energy scenario
2	Energy audit instruments
3	Electricity billing

Books	
Text Books:	
1.	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2.	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3.	S. C. Tripathy, —Utilization of Electrical Energy and Conservation‖, McGraw Hill, Reprint 1991
Reference Books:	
1.	W.R. Murphy&G. Mckey Butterworths, ”Energy Management”, New Age International Publishers, 2007
2.	Amit kumar Tyagi, Hand book on Energy Audit and Management, TERI (Tata Energy Research Institute).
3.	Rakosh Das Begamudre, Energy conversion systems, New Age International Publishers 10th Edition,2000
	E-resources:
1.	https://onlinecourses.nptel.ac.in/noc21_mm23/preview
2.	https://beeindia.gov.in/en/energy-auditors

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Explain t***he concepts of energy Scenario and energy conservation Act.	Un	1,9,10,12	1,2
2.	***Describe*** the theory of energy management and audit.	Un	1,2,12	1,2
3.	***Explain*** the concepts of energy efficiency in electrical systems	Un	1,6,7,12	1,2
4.	***Explain and Analyze*** the different energy efficient technologies in electrical system.	An	1,6,7,12	1,2
5.	***Explain*** the various energy conservation and audit concepts and submit a report.	Un	1,6,7,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	√					√	√					√	√	√		
5	√					√	√					√	√	√		
Tick mark the CO, PO and PSO mapping																

Sl no	Skill and competence enhanced after undergoing the course	Applicable industry sectors & domains	Job roles student can take up after undergoing the course
1	Students will be able to identify the various power losses in the given system	All industries include education institutes, malls, super markets etc..,	Energy Auditor and Energy manager
2	Suggest methods to plug the losses and increase the efficiency		
3	Identify the new methods for energy efficient technology		
4	Conduct the energy Audit		

Name and Signature of the faculty members involved in designing the syllabus

Name and signatures of faculty members verifying /approving the syllabus

EMBEDDED SYSTEMS

Course Code	22EEPE634	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 explain the ARM processor fundamentals and ARM cortex M3 in particular.
2.	To explain the architecture of LPC1768, instruction set and programming.
3.	To understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
4.	To develop the hardware software co-design and firmware design approaches.
5.	To explain the need of real time operating system for embedded system applications.

Pre-requisites : Microcontrollers

Unit – I	Contact Hours = 8 Hours
ARM PROCESSOR FUNDAMENTALS: 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	Contact Hours = 8 Hours
ARM CORTEX M3: 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, Opt coupler, 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:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the ARM processor fundamentals; ***outline*** the features of LPC 1768 processor and ***utilize*** its pin connect block for various applications.	Ap	1,5,10,12	3
2.	***Summarize*** the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	Un	1,10,12	3
3.	***Explain*** the hardware software co-design and firmware design approaches.	Un	1,10,12	3
4.	***Utilize*** real time operating system for embedded system applications.	Ap	1,10,12	3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	Knowledge of ARM processors & Embedded Systems	Mobile Application Development, Aerospace, Automotive, Construction, Information Technology, Healthcare.	Embedded & Control System Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ELECTRIC VEHICLE TECHNOLOGY

Course Code	22EEPE635	**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 = 20 Hrs Total = 50 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Prerequisites : Basic electrical and electronics, electrical machines and drives

Course learning objectives	
1.	To understand the overview of electric vehicles with respect to Indian & global market.
2.	To understand vehicle fundamentals, architecture and configuration of electric vehicle.
3.	To understand the EV motor and battery fundamentals and determining the size and type for EV application.
4.	To understand role and operation of BMS in EV
5.	To understand the application of MATLAB for building cell model, to realize cell characteristics, and to test BMS algorithm and test it experimentally

Unit – I	**Contact Hours = 6 Hours**
Introduction to Electric Vehicle Technology: Overview of electric vehicles in India and global scenario, EV benefits & challenges, typical EV system-structure & operating principle, types of electric vehicle-structure & operating principle of each type	

Unit – II	**Contact Hours = 6 Hours**
Vehicle Fundamentals: Longitudinal vehicle model, longitudinal resistance- aerodynamic drag, grading resistance, rolling resistance. total tractive force, maximum tractive effort and powertrain tractive effort, vehicle performance- maximum speed of a vehicle, gradeability, acceleration performance	

Unit – III	**Contact Hours = 6 Hours**
EV Architectures and Configurations: Architectural structures and configurations, major EV subsystems **Motors for EV:** Motor and engine ratings, EV and HEV motor requirements, types of EV motors-torque speed characteristics, important features & ratings, motor sizing & selection.	

Unit – IV	Contact Hours = 6 Hours
EV batteries: Battery parameters- cell and battery voltages, Charge (or Amphour) capacity, cut off voltage, max charge voltage, open circuit voltage, terminal voltage, C-Rating, Specific Energy , specific power, self-discharge rates. Battery sizing for EV, types of batteries for EV-lead acid, nickel based, lithium based-important ratings & features, merits and demerits	

Unit – V	Contact Hours = 6 Hours
Battery Management System (BMS): Need of BMS, functions of BMS, structure of BMS, SOC, DOD, SOH, Cell Balancing using static and active balancing technique, BMS algorithms	

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
IV , V	3	Cell testing & characterization
V	2	BMS algorithm implementation
II, III	2	EV Data Acquisition System
IV	1	Building battery pack

Unit No.	Self-Study Topics
III	Types of EV motors
IV	Types of batteries for EV-Lead acid, Nickel based, Lithium based-important ratings & features, merits and demerits
V	Cell Balancing

Books	
	Text Books:
1.	Electric Vehicle Technology Explained,James Larminie, John Lowry, 2nd Edition, wiley publication ISBN: 978-1-119-94273-3, September 2012.
2.	Electric Vehicle Engineering, Per Enge, Nick Enge, Stephen Zoepf, McGraw Hill , 1st Edition 2021
	Reference Books
1.	Electric Vehicle Technology, Prof. Suresh Pawar, Notion Press, September 2021.

2.	Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC PRESS, Boca Raton London New York Washington, D.C.
	E-resources
1.	https://nptel.ac.in/courses/108106170
2.	https://nptel.ac.in/courses/108102121

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Lab Test
3.	Flipped Classes	3.	Semester End Examination
4.	Practice session/Demonstrations in Labs		
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 terms related to vehicle fundamentals, architecture and configuration of electric vehicle.	Un	1, 12	1
2.	***Explain*** the battery parameters, function and operation of BMS.	Un	1, 12	1
3.	***Determine*** the parameters of battery and vehicle torque requirement.	Ap	2, 12	1
4.	***Analyse*** the performance parameters/characteristics of different subsystems of EV for sizing and selection.	An	2, 12	1,2
5.	***Build*** MATLAB model/codes for realization of characteristics of cell, BMS algorithms and analysis of EV data and test it experimentally.	Cr	2, 3, 5, 6, 7, 9, 10, 12	1, 3

Scheme of Continuous Internal Evaluation (CIE) for Integrated course:

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	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive.				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise 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: 15 marks 5. Viva voce: 10 marks				

Eligibility for SEE:
1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE**
2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.**
3. Lab test is COMPULSORY
4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.**
5. 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 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	PSO4
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	EV subsystem modelling	Automobile industry	EV/automotive engineer, R & D engineer,
2	BMS algorithms development and testing	Battery manufacturing and BMS testing	BMS develop/ testing engineer
3	MATLAB code development for EV application	Automobile sector, Battery manufacturing and testing,	BMS developer, control engineer, testing engineer, code developer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

LINEAR ALGEBRA

Course Code	22MAT641	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 This course will enable students to:	
1.	Basics in Abstract Algebra.
2.	Find the solution of the system of linear equations using matrix operations.
3.	Identify vector spaces and subspaces
4.	Transform a vector space of one dimension into another
5	Factorize a given matrix using different methods

Pre-requisites: Basic algebra. Matrix theory

Unit – I	Contact Hours = 8 Hours
Basic Abstract Algebra: Groups, Permutation Groups, Isomorphism, Fields, finite fields and examples.	

Unit – II	Contact Hours = 8 Hours
Vector Spaces: Vector spaces; subspaces; bases and dimension; coordinates; summary of row-equivalence; computations concerning subspaces.	

Unit – III	Contact Hours = 8 Hours
Linear Transformations: Linear transformations; algebra of linear transformations; isomorphism; representation of transformations by matrices;linear functional; Inverse of a linear transformation.	

Unit – IV	Contact Hours = 8 Hours
Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process; QR-factorization.	

Unit – V	Contact Hours = 8 Hours
Symmetric Matrices and Quadratic Forms: Diagonalization; quadratic forms;constrained optimization; Singular value decomposition.	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Fields and Rings with examples
2	Rank, nullity, Column space, Row space
3	Kernel of transformation, Inverse linear transformation
4	Applications of orthogonal vectors.
5	Least square solution of linear system of equations.

Books	
	Text Books:
1.	John B. Fraleigh, “A First Course in Abstract Algebra,” Narosa Publication 3rd edition onwards.
2.	David C. Lay, “Linear Algebra and its Applications,” Pearson Education (Asia) Pte. Ltd, 2005 3rd edition onwards.
3.	Kenneth Hoffman and Ray Kunze, "Linear Algebra," Pearson Education (Asia) Pte. Ltd/2004 2nd edition onwards.
	Reference Books:
1.	Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications”, Pearson Education(Asia) Pte. Ltd, 7th edition 2003 onwards.
2.	Gilbert Strang, "Linear Algebra and its Applications”, Thomson Learning Asia, 2003 3rd edition onwards.
	E-resources:
1.	https://onlinecourses.nptel.ac.in/noc24_ee138/preview
2.	https://onlinecourses.nptel.ac.in/noc24_ma69/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	Understand of algebraic structures.	Un	1	1
2.	Find bases and dimension of vector spaces.	Ap	1	1
3.	Understand the matrix theory in Linear transformation and applications	Un	1	1

4.	**Apply techniques of constrained optimization and singular value decomposition for problems arising in power/control system analysis, signals and systems.**	**Ap**	**1**	**1**

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts A,B and C. Students have to answer** **1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks.** **2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks.** **3. From Part C answer 1 out of 2questions, 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**
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Tick mark the CO, PO and PSO mapping															

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

APPLIED STATISTICS

Course Code	22MAT642	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 different terminology in statistics
2.	Get knowledge about various Dispersion parameters moments skewness
3.	Get familiar with Multiple Correlation and Regression
4.	Get acquainted with various Analysis of Variance (ANOVA) designs .One way and two way .
	Understand Non Parametric Tests processes.

Pre-requisites : : Basic statistics, Basic probability

Unit – I	Contact Hours = 8 Hours
Descriptive Statistics: Discrete and continuous data, Simple descriptive statistics - Mean, Median, Quantiles, percentiles, and quartiles, Variance, and standard deviation, Standard errors of estimates, Inter quartile range. Graphical statistics - Histogram, frequency polygon, and ogives, Stem-and-leaf plot, Box plot, Scatter plots, and time plots.	

Unit – II	Contact Hours = 8 Hours
Moments, Skewness and Kurtosis: Introduction to moments, Moments about the mean, Skewness , Negative Skewness , Positive Skewness, Kurtosis, Mesokurtic, Leptokurtic, Platykurtic -Practical, engineering related examples	

Unit – III	Contact Hours = 8 Hours
Multiple Correlation and Regression, Curve fitting: Multiple correlation and regression. Bivariate, Trivariate. Probable error of correlation coefficient. Spearman's rank correlation coefficient. Curvilinear regression. Standard error of estimate or residual variance. Least square Curve fitting and related error computation. Engineering related examples	

Unit – IV	Contact Hours = 8 Hours
Analysis of Variance (ANOVA): The Purpose of Analysis of Variance. One_ Way Classification. Variation within treatments. Variation between treatments. Total Variation. Expected values of the variation. Distribution of variations' ANOVA Tables. Two-way classification Variations for two-way classification. Experiments with replication. Experimental Design	

Unit – V	Contact Hours = 8 Hours
Non Parametric Tests: Introduction The Sign Test. The Mann-Whitney U Test. The Kruskal- Wallis H Test corrected for Ties. The run test for randomness. Further Applications of the Run test.Spear man's Rank Correlation	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Percentile ranks, quartile ranks.
2	Skewness and Kurtosis in Data Science.
3	Multiple regression in Machine Learning.
4	Calculate ANOVA using MS excel.
5	Wilcoxon's signed rank test, Kolmorogov-Smirnov test, Jonckheer test

Books	
	Text Books:
1.	B. S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012 and onwards.
2.	Fundamentals of Mathematical Statistics by S.C.Gupta and V.K.Kapoor., Sultan Chand and Sons, 2009 and onwards.
	Reference Books:
1.	Probability and statistics Schaum series second edition TAT Mc Graw Hill publication
2.	R Ganeshan -Research Mehtodology MJP Publishers
	E-resources:
1.	https://archive.nptel.ac.in/courses/111/102/111102111/ (Prob and Stochastic)
2.	https://archive.nptel.ac.in/courses/111/104/111104147/(Sampling and Linear regression)

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 Assignment (OA)/ Certification
4.	Online classes	4.	Course Project
		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.	To Understand different measures of Statistics	Un	1	1
2.	To Understand the concept Moments, Skewness and Kurtosis	Un	1	1
3.	To Apply methods of Multiple Correlation and Regression, Curve fitting and Analysis of Variance(ANOVA) for tabular data.	Ap	1	1
4.	To Understand the Non Parametric Tests	Un	1	1

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
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-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts A,B and C. Students have to answer** **1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks.** **2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks.** **3. From Part C answer 1 out of 2questions, each Question Carries 20 Marks.**

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**
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Tick mark the CO, PO and PSO mapping															

Name & Signature of Faculty members Involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

NANOSCIENCE AND NANOTECHNOLOGY

Course Code	22CH643	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 : NIL

Unit – I	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, SILAR Technique, Hydrothermal method.

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	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,

Unit – III	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.

Unit – IV	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	Contact Hours = 8 Hours
Switching glasses, Semiconductor devices including LEDs and Photonic crystals (1D, 2D and 3D) and their applications, Display devices TiO_2 and ZnO based photocatalysts, Photocatalysis Mechanism, Nanofiltration membranes-Dead end filtration method, Super hydrophobic materials-Lotus effect	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1.	Top-Down approach- Ball milling technique, Sputtering, Laser Ablation.
2.	Optical Spectroscopy- Instrumentation and application of IR, UV/VIS (Band gap measurement)
3.	Magnetic properties: Nanomagnetism, Magnetoresistance, Super Para Magnetism-Neel Relaxation time, blocking temperature etc. Mechanical Properties of nanomaterials
4.	Super capacitors: Introduction, construction and working of supercapacitor
5.	Nanosensors: Electrochemical sensors, Temperature Sensors, Chemical and gas Sensors, Light and radiation sensors.

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
3.	Nanotechnology, M. Ratner and D. Ratner, Prentice Hall 2003
4.	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.	Assignment- Open/Industry/Certification
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.	[L2]	1	
2.	Explain working of basic instruments used in characterization of nanoparticles.	[L2]	1	
3.	Discuss the application of nanotechnology to mechanical and civil domains	[L2]	1,4	
4.	Classify the nanomaterials based on the dimensions.	[L3]	1	
5.	Assess the suitability of nanomaterials for various device applications.	[L4]	1,6,12	

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:

1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:

-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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
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	Demonstrate the synthesis of nanoparticles by various techniques.	**Energy sector**	**R&D Engineer in Nanotechnology industries**
2	Explain working of basic instruments used in characterization of nanoparticles.	**Sensor Industry**	**QC Engineer**
3	Discuss the application of nanotechnology to mechanical and civil domains		

Name & Signature of Faculty members
Involved in designing the syllabus

Name & Signature of Faculty members
verifying/approving the syllabus

MARKETING MANAGEMENT

Course Code	22MBA644	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 make students understand the fundamental concepts of marketing and environment in which marketing system operates.
2.	To gain knowledge on consumer buying behavior and influencing factors
3.	To describe major bases for segment marketing, target marketing, and market positioning.
4.	To develop a Conceptual framework, covering basic elements of the marketing mix.
5.	To understand fundamental premise underlying market driven strategies and hands on practical approach.

Pre-requisites: The student should have basic awareness of market, products, services, buying-selling transaction and promotional activities

Unit – I	Contact Hours = 8 Hours
Introduction to Marketing: Importance of marketing, Definitions of market and marketing, Types of Needs, Elements of Marketing Concept, Functions of Marketing, Marketing V/s Selling, 4P's of Marketing, 7P's of service marketing, Marketing Environment.	

Unit – II	Contact Hours = 8 Hours
Analyzing Consumer Behavior: Meaning and Characteristics, Importance of consumer behavior, Factors influencing Consumer Behavior, buying behavior, personal factors, psychological factors and cultural factors. Consumer Buying Decision Process, Buying Roles, Buying Motives, The black box model of consumer behavior. Characteristics of generation Z consumers	

Unit – III	Contact Hours = 8 Hours
Product Management, Pricing and Branding: product levels, product hierarchy, classification of products, Managing Product Life Cycle, New Product Development, Packing as a marketing tool, Role of labeling in packaging. Types of Pricing Strategies Concept of Branding, Brand Equity, branding strategies	

Unit – IV	Contact Hours = 8 Hours
Distribution and Promotion: Roles and purpose of Marketing Channels, Factors Affecting Channel Choice, Integrated Marketing Communications (IMC)-Tools-Advantages, Disadvantages, Advertising Objectives, Advertising Budget, Advertising Copy, AIDA model,	

Unit – V	Contact Hours = 8 Hours
Market Segmentation, Targeting and Brand Positioning: Concept of Market Segmentation, Benefits, Requisites of Effective Segmentation, Bases for Segmenting Consumer Markets, Market Segmentation Strategies. Types of Segmentation. Targeting - Bases for identifying target Customer target Marketing strategies, Positioning - Meaning, Tasks involved in Positioning.	

Flipped Classroom Details

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

Unit No.	**Self-Study Topics**
1	Elements of Digital and social media Marketing, Green Marketing, Neuro Marketing, Sensory Marketing and societal marketing concept
2	Study the buying pattern based on demographics of consumers
3	Take any FMCG product and study the PLC, branding equity and pricing of that product.
4	Draft advertising copy

Books	
	Text Books:
1.	Kotler, P., Keller, K. L., Ang, S. H., Tan, C. T., & Leong, S. M. Marketing management: an Asian Perspective. Pearson Publication, (2018).
2.	Kotler, P., Kartajaya, H., &Setiawan, I. Marketing 4.0: Moving from traditional to digital. John Wiley & Sons, (2016).
3.	Ramaswamy, Namakumari, Marketing Management: Global Perspective, McGraw-Hill, (2019
	Reference Books:
1.	Dhruv Grewal, Michael Levy, Marketing Management, McGraw-Hill, (2018)
2.	Baines, P., Fill, C, Page, K. and Sinha, P.K, Marketing, Asian edition, Oxford University Press, New Delhi (2013)
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://youtu.be/5fdx5Laavkc
2.	https://youtu.be/ob5KWs3I3aY?t=131

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

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 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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.	Understand the basics concepts for Marketing and business environment	2	1	1
2.	Demonstrate the application of the knowledge with respect to strategic and tactical use of the primary decision-making areas of marketing	2	2	1
3.	Demonstrate and Apply the critical thinking ability needed to ensure Product and Brand sustainability	3	1	2
4.	Evaluate the needed strategies for distribution and promotion of products and services	4	6	3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:

1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:

-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
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	Strategic decision making	Retail, Service	Product Managers
2	Branding knowledge	Retail, Service	Brand Managers
3	Business Communication	Retail, Service, Branding	Advertising Consultants

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

FUZZY LOGIC AND APPLICATIONS

Course Code	22EEOE645	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 understand the basic principles of crisp and fuzzy sets.
2.	To understand the theory of approximate reasoning and justify the use of the rules.
3.	To analyze and summarize the FKBC structure and understand the concept of fuzzification and defuzzification
4.	To design a typical fuzzy logic controller for various applications.
5.	To understand the concepts of adaptive mechanism for the fuzzy based controllers

Pre-requisites : Classical 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, aircraft landing Control, water level control, lift 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	1	nil	nil	1	1

Unit No.	Self-Study Topics
1	Classical set theory

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:
1.	https://nptel.ac.in/courses/108104157

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***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) for Theory course:

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	✓	✓	✓		✓				✓	✓			✓	✓		
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, power systems	R&D Engineer, system engineering

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

RENEWABLE ENERGY SOURCES

Course Code	22EEOE646	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 understand the energy scenario of the world
2	To understand of the solar geometry and how it is used for renewable energy analysis.
3	To explain the energy generation from solar thermal and photovoltaic systems.
4	To Explain concept of energy conversion process from biomass and construction of different biomass plants.
5	To understand the fundamentals of energy generation from wind source.
6	To understand the fundamentals of batteries and fuel cells and its use in industrial and commercial contexts

Pre-requisites : Basic Electricals, Energy sources

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;

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, numerical problems.	

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.	

Flipped Classroom Details

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

Unit No.	**Self-Study Topics**
1	Per capita energy consumption
2	Domestic lighting
3	Biomass program in India
4	Wind energy scenario – World and India
5	Emerging trends in batteries

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:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the renewable energy concept, battery technology and fuel cell.	Un	1,6,7,9,10,11,12	1,2
2.	***Illustrate*** the power generation by various renewable energy sources	Un	1,6,7,9,10,11,12	1,2
3.	***Plan*** Solar & Wind energy systems	Ap	1,3,6,7,9,10,11,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
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Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	✓		✓			✓	✓		✓		✓	✓	✓		✓	✓
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 & wind energy systems	Solar & Wind Power industry	Design/Site Engineer
2	Concept of fuel cells	R&D in energy sector	R&D Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ENERGY STORAGE SYSTEMS

Course Code	22EEOE647	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 understand the principles of design and operation of battery/storage technology systems
2.	To analyze and evaluate different battery technologies available in the market
3.	To design and develop energy storage solutions using battery technology
4.	To understand the impact of battery technology on the environment and society

Pre-requisites : Basics cell chemistry.

Unit – I	**Contact Hours = 8 Hours**
ENERGY STORAGE: Necessity of energy storage, battery basics, introduction to electric vehicle batteries, fuel cell technology, choice of a battery type for electric vehicles	

Unit – II	**Contact Hours = 8 Hours**
ELECTROCHEMICAL BATTERY: Electrochemical batteries, electrochemical reactions, states of the battery, thermodynamic voltage, specific energy, specific power, and energy efficiency	

Unit – III	**Contact Hours = 8 Hours**
MODERN STORAGE SYSTEMS: Ultracapacitors: Features, basic principle, performance, ultra-capacitors technology, advanced materials and technologies for super-capacitors **Flywheels**: Principle of operation, power capacity, flywheel technology	

Unit – IV	**Contact Hours = 8 Hours**
Lithium Ion Battery: Principle of operation, lithium-metal polymer batteries, li – air batteries, li – sulphur batteries, li resources and recycling of li-ion batteries	

Unit – V	**Contact Hours = 8 Hours**
Hybrid Energy Storage: Concept of hybrid energy storage, passive and active hybrid energy storage with batteries & ultra-capacitors, applications of energy storage systems, ups, battery bank systems, and electric vehicles, hydrogen storage systems and modern trends in energy storage	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Choice of a Battery Type for Electric Vehicles
2	Electrochemical reactions
3	Advanced materials and technologies for super-capacitors
4	Li resources and recycling of Li-ion batteries

Books	
	Text Books:
1.	Bruno Scrosati, Jürgen Garche, Werner Tillmetz, "Advances in Battery Technologies for Electric Vehicles", Woodhead Publishing Series in Energy, 1st Edition, 2015.
2.	Christian Glaize, Sylvie Genies, "Lithium Batteries and other Electrochemical Storage Systems", Wiley-ISTE, July 2013.
	Reference Books:
1.	MehrdadEhsani , Yimin Gao, Stefano Longo, KambizEbrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2018
	e-resources:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the necessity of Energy Storage system	Un	1, 6, 7,10	1
2.	***Explain*** the construction & operation of different types of batteries	Un	1, 6, 7,10,12	1, 2
3.	***Explain*** the Integration with Renewable Energy, Economic and Environmental Impact	Un	1, 6, 7,10, 12	1, 2
4.	***Explain*** the applications of various types of batteries	Un	1, 6, 7, 12	1, 2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	Understanding and analyzing energy storage technologies	Renewable Energy and Utilities	Energy Storage Engineer
2	Installing, maintaining, and optimizing energy storage systems	Electric Vehicles and Industrial Applications	Renewable Energy Specialist, Grid Analyst, Project Manager, Research Scientist
3	Managing projects, ensuring compliance, and effective stakeholder communication	Residential and Research	Energy Consultant, Product Manager

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

PLC AND INDUSTRIAL AUTOMATION

Course Code	22EEOE648	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 understand 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 understand and demonstrate instruction lists, sequential function charts & structured text, and subroutines**.**
4.	To demonstrate Ladder programs and control relay.
5.	To understand and demonstrate different types of timers and counters, programming with timers and counters.

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

Unit – I	Contact Hours = 8 Hours
INTRODUCTION TO PLC: 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, I/O units, signal conditioning, remote connections, networks, processing inputs I/O addresses.	

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

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

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

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

Flipped Classroom Details

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

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.
	E-resources
1.	https://nptel.ac.in/courses/108105063

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Explain*** basics of PLC, architecture, hardware and I/O devices.	Un	1,2	1
2.	***Explain*** ladder programming, logic functions, latching, multiple outputs, functional blocks and emergency switches.	Ap	1,2,3,5,6	1,2,3
3.	***Explain and make use of*** instruction list, sequential functions charts & structured text, subroutines.	Ap	1,2,3,5,6	1,2,3
4.	***Develop*** ladder programs and explain control relay.	Ap	1,2,3,5,6,10,11	1,2,3
5.	***Explain*** different type of timers and counters, programming with timers and counters.	An	1,2,3,5,6,10,11	1,2,3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**			
CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	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

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Name & Signature of Faculty members verifying/approving the syllabus

EMPLOYABILITY SKILLS II

Course Code	22AECEE66	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 = 30 Hrs; T = 0 Hrs; P = 0 Hrs Total = 30 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

Pre-requisites :

Unit – I	Contact Hours = 4 Hours
Quantitative Aptitude*:** Ratios, Proportions and Variations (2 Hours), Partnership (1 Hour), Time and Work (2 Hours) ***Logical Reasoning: Seating Arrangement (1 Hour)	

Unit – II	Contact Hours = 4 Hours
Quantitative Aptitude*:** Time, Speed and Distance (2 Hours), Trains, Boats and Streams (2 Hours) ***Verbal Ability: Reading Comprehension (2 Hours)	

Unit – III	Contact Hours = 4 Hours
Quantitative Aptitude*:** Permutation and Combination (2 Hours), Ages (1 Hour) ***Logical Reasoning: Data Arrangement (1 Hour) ***Soft Skills:*** Interview Skills (1 Hour), Resume Building (1 Hour).	

Unit – IV	Contact Hours = 4 Hours
Quantitative Aptitude*:** Probability (2 Hours) ***Logical Reasoning: Clocks and Calendars (2 Hours), Syllogisms (2 Hours)	

Unit – V	Contact Hours = 4 Hours
Quantitative Aptitude*:** Data Interpretation (2 Hours) ***Logical Reasoning: Data Sufficiency (2 Hours) ***Verbal Ability*:** Ordering of Sentences (1 Hour), Critical Reasoning (1 Hour)	

Books	
	Text Books:
1.	The Aptitude Triad , BIZOTIC
2.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.
3.	How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
4.	How to prepare for Verbal Ability and Reading Comprehension for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
5.	How to prepare for Data Interpretation for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 5th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes
		3.	Assignments
		4.	Seminar

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	10,12	
2.	Perform confidently during the Interview process	L2	10,12	
3.	Develop resumes that are grammatically correct and written in Business English	L2	10,12	
4.	Develop behaviors that are appropriate for a professional	L2	10,12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two Assignments	Total Marks
Marks	30+30 = 60	20	10+10 =20	100
- Writing 2 IA tests are compulsory **-Student should score minimum 40% of 100 marks to pass the course.**				

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	Logical Thinking	IT Industry	Software Engineer
2	Problem Solving	Automotive	Developer
3	Communication Skills	Education Sector	Project Manager

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ADVANCED C WITH C++ LAB

Course Code	22EEL68	Course type	PCCL	Credits L-T-P	0 - 0 - 1
Hours/week: L - T- P	0 - 0 - 2			Total credits	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			CIE Marks	50
Flipped Classes content	NIL			SEE Marks	50

Course learning objectives	
1.	To **understand** the concepts of C Programming language
2.	To **understand** the concepts of Data structure using C.
3.	To **study** about constructor, destructor and its usage.
4.	To **study** importance of inheritance, polymorphism in C++
5	To **study** importance of passing objects to function in C++

Required Knowledge of : C programing

Lab Experiment – I	Contact Hours = 2 Hours
Multiplication of two matrices and transpose of a Matrix	
Lab Experiment – 2	Contact Hours = 2 Hours
calculator implementation in C using pointers	
Lab Experiment – 3	Contact Hours = 2 Hours
Simple banking application in C by making use of array of Structures	
Lab Experiment – 4	Contact Hours = 2 Hours
Program to implement a stack using an array.	
Lab Experiment – 5	Contact Hours = 2 Hours
Program to implement a Queue using an array.	
Lab Experiment – 6	Contact Hours = 2 Hours
Program to implement array of objects to process CIE Data.	
Lab Experiment – 7	Contact Hours = 2 Hours
Program to implement function overloading concept.	
Lab Experiment – 8	Contact Hours = 2 Hours
Program to implement the concept of passing objects to function by 1. Value 2. reference	
Lab Experiment – 9	Contact Hours = 2 Hours
Program to implement the hybrid inheritance	
Lab Experiment – 10	Contact Hours = 2 Hours
Program to illustrate the use of operator overloading.	

Books	
	Text Books:
1.	Balagurusamy E, Computing Fundamentals And C Programming|2nd Edition, Tata McGraw Hill Education Pvt.Ltd, 20 September 2017 onwards
2.	Balagurusamy E, Object Oriented Programming with C++, Tata McGraw Hill Education Pvt.Ltd , Fourth Edition 2010.
3.	Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, Second Edition, 2012 onwards
4.	Yashavant Kanetkar, Let Us C – 13 July 2016 15th edition, BPB Publications.
	E-resources
1.	https://onlinecourses.swayam2.ac.in/aic20_sp06/course
2.	https://onlinecourses.swayam2.ac.in/aic20_sp01/course
3.	spoken-tutorial.org (MOOCs from IITM)

Course delivery methods		Assessment methods	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
		4.	Lab Test
		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.	***Explain*** the basic concepts of C programming	Un	1,5	3
2.	***Explain*** the basic concepts of Object-Oriented programming	Un	1,2,5	3
3.	***Make use of*** functions for modularity	Ap	1,2,3,4,5	3
4.	***Implement*** the concepts of Data structure using C	Ap	1,2,3,4,5	3
5.	***Implement*** the concepts of Object oriented programming such as polymorphism, Inheritance	Ap	1,2,3,4,5	3

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expt	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

1. Conduction of the experiment: 15 marks + Viva voce: 5 marks
2. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks
3. Lab project/ Open ended expt: 10 marks

3. Lab Test: 15 marks

Eligibility for SEE:

1. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

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	deep understanding of **programming language**	**Software**	**Software developer and Test Engineering**
2	solve complex problems	**ASP Design**	**Data Science Engineer**
3	Write and debug code	**Hardware / Embedded**	**Team Leader**

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7TH SEMESTER

COMPUTER APPLICATIONS IN POWER SYSTEM ANALYSIS

Course Code	22EE71	**Course type**	IPCC	**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 explain formulation of network models and bus admittance matrix
2.	To understand & explain load flow analysis and the different techniques used for Load flow analysis
3.	To explain optimal operation of generators on a bus bar and optimum generation scheduling.
4.	To formulate bus impedance matrix to apply for short circuit studies and explain the solution of swing equation using numerical methods.
5.	To explain & develop source codes in MATLAB and use Power System Simulation packages for analyzing & simulating various power system problems.

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, formation of Incidence Matrices, Primitive network- Impedance form and admittance forms, formation of Y_{BUS} by Singular Transformation, Y_{bus} by Inspection Method, Algorithm & Flowchart, 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 , Algorithm & Flowchart, Illustrative examples	

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

Unit IV: Economic Load Dispatch & Unit Commitment	**Contact Hours = 8 Hours**
Introduction, 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: Z_{bus} & Stability Studies	**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, Modification of Z_{bus} for removal/changing the impedance value of elements. 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	Y_{bus} Formations, Line flows and power flows
2	1	Load flow studies using GS method
3	2	Load flow studies using NR method/Jacobian Formation
4	1	Optimal Generator Scheduling
5	2	Z_{bus} formation, Swing Equation

Unit No.	**Self-Study Topics**
2.	Algorithm & Flowchart of GS method
3.	Algorithm & Flowchart of NR & FDLF method
4.	Unit Commitment

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.	Lab Test
3.	Flipped Classes	3.	Semester End Examination
4.	Practice session/Demonstrations in Labs		
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.	***Make use of*** network matrices and models for **constructing** Y_{bus}	Ap	1,2,12	2
2.	***Develop*** the load flow solutions using different Numerical iterative techniques and ***analyze*** those solutions.	An	1,2,12	2
3.	***Plan*** the optimal scheduling of generators and **explain** the unit commitment.	Ap	1,2,12	2
4.	***Build*** Z_{bus} and ***apply*** Numerical Methods for solution of Swing Equation.	Ap	1,2,12	2
5.	***Develop Programs*** in MATLAB and ***make use of*** simulation softwares like ETAP for Power System studies.	Ap	1,2,5,9, 10,12	2, 3

Scheme of Continuous Internal Evaluation (CIE) for Integrated course:

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	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive.				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise 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: 15 marks 5. Viva voce: 10 marks				
Eligibility for SEE: 1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE** 2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.** 3. Lab test is COMPULSORY 4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.** 5. 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 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	Modelling of Power Systems, Simulation of power system networks, Code/program developer for power system applications	Power Systems-Grids, Transmission & Distribution Companies, Core Industries, Consultancy	Power System- Design, maintenance and control Engineer, Consultants and commissioning entrepreneurs.

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

POWER SYSTEM PROTECTION AND HIGH VOLTAGE ENGINEERING

Course Code	22EE72	**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 understand the fundamentals of protective systems and relays.
2.	To explain and understand the basic principle and types of circuit breakers and relays
3.	To understand the electric breakdown phenomenon in solid, liquid, and gaseous insulating mediums.
4.	To understand the various methods of generation of HVAC, HVDC, Impulse voltage and current.

Pre-requisites : Fundamentals of power systems

Unit – I	**Contact Hours = 8 Hours**
Protective Relaying: - Requirements of protective relaying, zones of protections, essential qualities of protective Relaying. **Relays and feeder protection:** Directional over current relay, impedance relay, reactance relay, negative sequence relay, static relay, numerical relay. **Principle of AC Circuit breaking**: Arc and arc interruption theories. Re striking voltage, recovery voltage, rate of rise of re- striking voltage, current chopping. SF6 circuit breaker.	

Unit – II	**Contact Hours = 8 Hours**
Apparatus Protection: Differential protection of 3-phase circuits, differential protection of transformer, bus zone protection, generator protection, Motor protection.	

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**: primary and secondary ionization processes. criteria for gaseous insulation breakdown based on Townsend's theory of breakdown in non-uniform fields. Corona discharges, breakdown in electro negative gases, 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: 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 circuit, trigatron gap. (No derivation)	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
3	Various types of dielectric materials

Books	
Text Books:	
1.	Sunil S Rao, "Switchgear and Protection, Khanna Publication, 14th Edition, Khanna Publishers, 1977
2.	Badri Ram and Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, 2013,TMH
3.	M.S.Naidu and Kamaraju, "High Volatge Engineering", 5th Edition, 1982, MHE(Ind).
4.	C.L.Wadhwa "High Volatge Engineering" , 3rd Edition, 2010, New Age International Private limited.
Reference Books:	
1.	Soni, Gupta, Bhatnagar, "A course in Electrical Power" , 9th Edition, 1987, Dhanpath Rai Publication
2.	E.Kuffel and W.S. Zaengl, High Voltage Engg fundamentals, 2nd Edition, 2000, Elsevier Press.
	E-resources:
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.	Assignment- Open/Industry/Certification
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.	***Explain*** the basic principle of protective relaying and understand the working of different types of relays.	Un	1,2,12	1,2
2.	***Explain*** the types and operation of various circuit breakers	Un	1,2,12	1,2
3.	***Analyze*** the various breakdown phenomenon in gases, solid, and liquid insulating medium.	An	1,2,12	1,2
4.	***Explain and analyze*** the generation of HVAC, HVDC and impulse voltage and current.	An	1,2,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)												CO-PSO Mapping (Planned)				
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	Power system Protection	Power sector	JE, Electrical Engineer , AE
2	High Voltage Testing	High voltage, Testing	JE, Electrical Engineer, AE

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus. .

ELECTRICAL DRIVES AND TRACTION

Course Code	22EE73	**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 explain general electric drive& dynamics principles.
2.	To explain types of electric drives, power ratings, performance characteristics, analysis & selection of DC and AC drives.
3.	To explain operation & speed/torque control techniques for DC & AC drives.
4.	To explain & analyze braking techniques for DC and AC drives.
5.	To explain the basics of electric traction & analyze its performance

Pre-requisites: Electric Machines and Power Electronics

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, Numerical	

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, Numerical	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1.	Choice of Electrical Drives, Status of DC and AC Drives.
4.	Classes of motor duty cycle

Books	
	Text Books:
1.	G.K.Dubey, “Fundamentals of Electrical Drives”,second edition, Narosa Publications.
2.	S.L.Uppal, “Electrical Power”, Khanna Publishers.
	Reference Books:
1.	S.K. Pillai, “First Course in Electrical Drives” , Fourth edition, TMH Publications.
2.	N.K.De and P.K.Sen, “Electrical Drives”, TMH Publication
	E-resources:
1.	https://archive.nptel.ac.in/courses/108/104/108104140/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Explain*** the operation of electric drive, dynamic principles, and performance characteristics.	Un	1, 12	1,2
2.	***Apply*** speed/torque control techniques for DC & AC drives.	Ap	1,2, 12	1,2
3.	***Analyze*** braking techniques for DC and AC drives.	An	1,2,3,12	1,2
4.	***Analyze*** the performance and selection of motors for different drives and traction applications.	An	1,2,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	Selection of AC and DC drives & control	Railways, Foundries, Factories	Drive Engineer, Traction controller, Maintenance Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT

Course Code	22EEPE741	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 know the performance parameters and specifications of various electrical equipment as per standards
2.	To study various tests on electrical equipment prior to and after commissioning
3.	To learn the methods of installation and maintenance procedures of various electrical equipment

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, Bucholtz relay, oil filtration unit, drying of Windings

Unit – II	Contact Hours = 8 Hours

Commissioning Tests: National and International Standards, volts ratio, earth resistance, oil strength, insulation tests, impulse test, polarizing index, load temperature rise tests, checking of auxiliary relays like PRV, OSR, checking of OLTC operation manually and with RTCC, cooling fans and pump operation, checking of WTI, OTI operation

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: specifications, 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

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, concept of HVDC circuit breaker, maintenance of circuit breaker, breaker timing test, contact resistance measurement test DCRM **Tests on CTs and PTs:** Ratio test, polarity test, knee point voltage test, specification of PT, errors in PT and CT, effect of secondary open circuit, procurement of CT, testing of CT	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
IV	Maintenance of induction motors
V	Maintenance of circuit breaker

	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., reprint 2019.
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".
	E-resources:
	https://onlinecourses.nptel.ac.in/noc21_ee110

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	Describe the standards in the process of planning and commissioning of electrical equipments.	Un	1,6,9,10	1,2
2.	Specify the standards of specifying the ratings of electrical equipments.	Un	1,6,9,10	1,2
3.	Discuss the standard tests to be conducted on electrical equipments.	Un	1,6,9,10	1,2
4.	Describe the maintenance schedule of various electrical equipments.	Un	1,6,9,10	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

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	Ordering the equipment	Private and govt sectors, Contracts	Power system engineer, commissioning and maintenance contractor
2	Commissioning of equipment	Private and govt sectors, Contracts	Power system engineer, commissioning and maintenance contractor
3	Maintenance of equipment	Private and govt sectors, Contracts	Power system engineer, commissioning and maintenance contractor

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

FLEXIBLE A.C. TRANSMISSION SYSTEMS

Course Code	22EEPE742	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 discuss the basic concepts of FACTS.
2.	To select power semiconductor devices and convertor configuration for FACTS applications.
3.	To understand series and shunt FACTS devices.

Pre-requisites : Basic electrical engineering, Transmission & Distribution, Power electronics converters.

Unit – I	Contact Hours = 8 Hours
Basics of FACTS: Classifications of transmission lines, equivalent circuit of a transmission line, performance requirement of transmission line, derivation for active and reactive power flow 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 – II	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.	

Unit – III	Contact Hours = 8 Hours
Static Shunt Compensation: Objectives of shunt compensation, midpoint voltage regulation, prevention of voltage instability , methods of controllable var generation, variable impedance type static var generators, TCR & TSC operation and its VI Characteristics.	

Unit – IV	Contact Hours = 8 Hours
SVC and STATCOM: TSC –TCR, FC TCR operation, VI characteristics, basic operating principles of STATCOM , reactive power generation by synchronous compensator & VSC, VI and VQ characteristics of SVC and STATCOM, Concept of UPFC.	

Unit – V	Contact Hours = 8 Hours
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), basic two machine system with SSSC and its operation.	

Flipped Classroom Details

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

Books	
	Text Books:
1.	N.G. Hingorani and L.Guygi "Understanding FACTS Devices" IEEE Press Publications 2000.
	Reference Books:
1.	S.Rao,Khanna publishers, "EHV - AC, HYDC Transmission & Distribution Engineering", 3rd edition.
2.	K.R. Padiyar, "FACTS - Controllers in Power Transmission distribution", New age publishers.
	E-resources
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.	Assignment- Open/Industry/Certification
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.	***Analyze*** various FACTS controllers with controllable parameters	An	1,2,12	1,2
2.	***Explain*** basic concepts of various voltage sourced converters	Un	1,2,12	1,2
3.	***Identify*** suitable configuration for the system from a list of shunt & series compensation circuits	Un	1,2,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	Technical and conceptual skill	Power system industries, NPCL,KPTCL	Design/maintenance/power engineer

Name & Signature of Faculty members members involved in designing the syllabus

Name & Signature of Faculty verifying/approving the syllabus

SPECIAL ELECTRICAL MACHINES

Course Code	22EEPE743	**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 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

Unit No.	Self-Study Topics
1	Constructional features
2	Constructional features
3	Permanent Magnet materials
4	PMSM Applications.
5	Constructional features, Types

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.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***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.	Un	1,2,12	2
2.	***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	1,2, 12	2
3.	***Analyze and Identify*** the applications of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors and permanent magnet synchronous motors.	An	1,2,12	2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)			
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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, Traction and drives	Maintenance, Automation & Design Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

SMART GRID

Course Code	22EEPE744	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 the need for smart grid and challenges in implementation of smart grid
2.	To understand and explain the substation automation, feeder automation
3.	To identify and describe the issues of power quality aspects in smart grids
4.	To understand the concepts of smart metering and PMU
5.	To 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**
Introduction to smart grid: 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**
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, fuel cells, micro-turbines, 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

Unit No.	Self-Study Topics
1	Conventional grid
2	Hybrid electric vehicles
5	Variable speed wind generators, fuel cells

Books	
	Text Books:
1.	Radian Belu , "Smart Grid Fundamentals Energy Generation, Transmission and Distribution first edition, Illustrations Publishers, CRC Press, 2024.
2.	Bernd M. Buchholz and Zbigniew A. Styczynski , "Smart Grids", edition -2, published by Springer Berlin, Heidelberg,2020.
3.	C. Sankaran, "Power Quality", CRC Press LLC, 2002.
	Reference Books:
1.	Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", 2nd edition, CRC Press, 2013.
2.	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley publications, 2012.
3	Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, 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.
4	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.
	E-resources:
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.	Assignment- Open/Industry/Certification
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.	***Understand*** the need for smart grid and challenges in implementation of smart grid.	Un	1,2, 12	1,2
2.	***Understand and explain*** the Substation Automation, Feeder Automation	Un	1,2,3,6,7,10 12	1,2
3.	***Identify*** and ***describe*** the issues of power quality aspects in smart grids.	Ap	1,2, 6,7,10 , 12	1,2
4.	***Apply*** the concepts of smart metering and PMU.	Ap	1,2,12, 6,7,10	1,2
5.	***Illustrate*** an understanding of micro grids and distributed energy resources	Un	1,2,3,4, 6,7,10 12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)												CO-PSO Mapping (Planned)			
CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	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.

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

MODERN CONTROL THEORY

Course Code	22EEPE745	**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 define** and **construct** state models for LTI systems and **demonstrate** their applications.
2.	**To analyze** the LTI systems using state models in terms of Eigen values, Eigen vectors and state transition matrix.
3.	**To assess** the controllability, observability of a system and **design** controller, observer respectively for a given system .
4.	**To identify** and **understand** the common physical nonlinearities and **describe** their properties.
5.	**To 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 space modelling and analysis: 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: Phase variables and canonical variables method, 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. Design of state regulator and state observer. Concept of controllability & observability and its determination 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 and multi variable non-linearity. **Phase plane analysis:** Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
V	Phase plane analysis

Books	
	Text Books:
1.	I. J. Nagarath& M. Gopal, "Control system Engineering", New Age International (P) Ltd, 3rd edition.
2.	Benjamin C. Kuo&FaridGolnaraghi, "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.
3.	Katsuhiko Ogata , "State Space Analysis of Control Systems", PHI.
	E-Resources:
1.	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.	Assignment- Open/Industry/Certification
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.	***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.	Ap	1,2,5,12	1,3

3.	***Analyze*** the system stability using state space techniques such as STM, controller & observer.	An	1,2,5,12	1,3
4.	***Design*** a controller & observer.	Ap	1,2,3,12	1,3
5.	***Analyze*** nonlinear systems & evaluate stability.	An	1,2,5,12	1,3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)												**CO-PSO Mapping (Planned)**			
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	Competitive exams	Aerospace	Modelling of a system
2	Design a state space model	Machine dynamics	Analysis of a System
3	Techniques used to validate a system	Linearized model	Validation of a System

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

OPTIMIZATION TECHNIQUES

Course Code	22MAT751	**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 understand the methodology of OR problem solving and formulate linear programming problem. Solve linear programming problems using simplex method
2.	Develop formulation skills in transportation models and finding solutions. Understand the basics of Assignment Problems.
3.	Analyze dynamic games and understand queuing theory models and applications.
4.	To know how project management techniques help in planning and scheduling a project.

Pre-requisites : Basic algebra, Matrix theory, Probability

Unit – I : Introduction to OR and Linear Programming Problem	**Contact Hours = 8 Hours**

Evolution of OR, definition of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR,Linear Programming Problem, Convexity and Basic Feasible Solutions. Formulation and examples, Graphical Solution, Convex and polyhedral sets, Extreme points, Basic solutions, Basic feasible solutions, Correspondence between basic feasible solutions and extreme points.

Unit – II : Simplex method and Duality	**Contact Hours = 8 Hours**

Simplex method, Canonical and Standard form of LP problem, Optimality criterion, slack and surplus variables, Solutions to LPP by Simplex method . Formulation of the dual problem, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.

Unit – III : Transportation and Assignment Problem	**Contact Hours = 8 Hours**

Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, Least-cost method, Vogel approximation method, Algorithm for obtaining optimal solution using MODI method. Formulation of assignment problems, Hungarian method.

Unit – IV : Game Theory and Queuing Theory	**Contact Hours = 8 Hours**

Formulation of two-person zero-sum games, Games with mixed strategies, Graphical method for solving matrix game, Dominance principle, Solution of game problem.

Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Unit – V : Network Analysis	**Contact Hours = 8 Hours**

Network Scheduling by CPM-PERT: Rules of Network construction, Numbering of events(Fulkerson's rule), Construction of network, Time analysis: Forward Pass computation, Backward Pass computation, Determination of Floats and Slack times, Critical Path Method (CPM), Program Evaluation Review Technique (PERT). Cost analysis in networks - Problem

Flipped Classroom Details

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

Unit No.	**Self-Study Topics**
1	Scope of OR, application areas of OR
2	Solving LPP by Generalized simplex method, Degeneracy in LPP
3	Travelling sales man problem
4	Linear programming method to solve without saddle point
5	Crashing of networks

Books	
	Text Books:
1.	Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.
2.	Operations Research, S D Sharma Kedarnath, Ramnath & Company.
3.	Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd. 2016
4.	Operations Research, Anand Sharma, Himalaya Publishing House.
	Reference Books:
1.	Introduction to Operations Research, Hillier and Lieberman, 8th Ed., McGraw Hill.
2.	Hamdy A. Taha (2017). Operations Research: An Introduction to Linear Programming and Game Theory (3rd edition)
	E- resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	http://www.class-central.com/subject/math(MOOCs)
2.	http://academicearth.org/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	Understand linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.	Un	1	1
2.	Analyse the transportation models' solutions and infer solutions to the real-world problems recognize and solve assignment problems.	An	1	1
3.	Apply theory of pure and mixed strategy games and queuing theory models.	Ap	1	1
4.	Apply Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems.	Ap	1	1

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Tick mark the CO, PO and PSO mapping															

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

COMPLEX ANALYSIS AND SPECIAL FUNCTIONS

Course Code	22MAT752	**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 complex valued functions.
2.	Apply conformal mapping to find the image of region.
3.	Apply various integral formulae for dealing with complex integration
4.	Understand the importance of special functions.

Pre-requisites :Basic knowledge of complex numbers, algebra and series solution

Unit – I	**Contact Hours = 8 Hours**
Complex Analysis-I Functions of complex variables, Analytic functions, CR equations- Cartesian and Polar form(with proof), Properties of analytic functions, Applications to flow problems-velocity potential, complex potential, stream functions and stream lines. Harmonic functions	

Unit – II	**Contact Hours = 8 Hours**
Conformal Transformation, Condition for conformality, Mappings : $w = Z^n$ $w = Z^2$,$w = e^z$, $w = z + (a^2/z)$. Bilinear transformation. Cross ratio Fixed points. Numericals based on different regions.	

Unit – III	**Contact Hours = 8 Hours**
Line integral in complex plane, Cauchy's theorem and consequences, Cauchy's integral formula and residue theorem, Singularities and residues. Laurent's series. Region of convergence. Numericals on all above.	

Unit – IV	**Contact Hours = 8 Hours**
Bessel function: Bessel equation and its origin,solution, Bessel function of first kind,$J_0(x)$, $J_1(x)$, $J_{0.5}(x)$, $J_{-0.5}(x)$ Recurrence relations, More J values. Generating function, orthogonality. Numericals on above	

Unit – V	**Contact Hours = 8 Hours**
Legendre function: Legendre equation and its origin, solution, Legendre polynomial,Rodrigues formula Recurrence relations, Generating function, orthogonality. Numericals on above	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Proof of C R equations.
2	Trigonometric transformations: sin z, cos z, tan z.
3	Taylor's and Maclaurin's series.
4	Graphs of various Bessel function.
5	Rodrigues formula derivation.

Books	
	Text Books:
1.	B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.
2.	B. V. Ramana- Higher Engineering Mathematics,Tata McGraw-Hill Publishing Company Ltd. Tenth reprint 2010 and onwards.
	Reference Books:
1.	P.N.Wartikar & J.N.Wartikar– Applied Mathematics (Volume I and II) Pune Vidyarthi Griha Prakashan, 7th Edition 1994 onwards.
2.	Functions of One Complex Variable" by John B. Conway, 2004 edition onwards.
3.	Special Functions & Their Applications, by N.N.Lebedev, 2004 edition onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://www.shiksha.com/online-courses/numerical-methods-for-engineers-course-courl3484
2.	https://www.coursera.org/learn/complex-analysis

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	To Understand the complex function as generalisation.	Un	1	1
2.	To Apply conformal mapping for image processing.	Ap	1	1
3.	To Understand complex integration and its properties	Un	1	1
4.	To Understand the role of special functions in applications.	Un	1	1

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100
IA Test: 1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks). 2. Remaining 20 marks questions in Part B & C should be descriptive -Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.				
Eligibility for SEE: **-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.** **-Lack of minimum score in IA test will make the student Not Eligible for SEE.** **-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosingany one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2questions, 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**
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Tick mark the CO, PO and PSO mapping															

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

INTRODUCTION TO ASTRONOMY

Course Code	22PHY753	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 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 the 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	**2**	**2**	**2**	**2**	**2**

Unit No.	**Self-Study Topics**
1	Relativistic Doppler effect
2	Radiative transfer in the sun
3	H-R diagram of nearby by stars
4	Stellar population in Milky way
5	Geometry of space and time in flat spacetime

Books	
	Text Books:
	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.	Assignment- Open/Industry/Certification
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.	Apply nuclear physics, statistical physics to understand working and end states of stars.	Ap	1	

2.	Understand classification of stars and binary systems.	Un	1	
3.	Understand structure of galaxy and expansion of the universe	Un	1	
4.	Apply general relativity to understand cosmology	Ap	1	

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IA Test:
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-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):

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Minimum marks required in SEE to pass: Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.

Question paper contains three parts **A,B and C**. Students have to answer
1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks.
2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks.
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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															

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Name & Signature of Faculty members verifying/approving the syllabus

HUMAN RESOURCE MANAGEMENT FOR ENGINEERS

Course Code	22MBA754	**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 understand and analyze human resource functions within organizations
2.	To examine current issues, trends, practices, and processes in HRM
3.	To contribute to employee performance management and organizational effectiveness
4.	Problem-solve human resource challenges

Pre-requisites : Students need to be aware of the basic HR terminologies

Unit – I	**Contact Hours = 8 Hours**
Introduction to Human Resource Management: Definition, The Manager's Role in Strategic Human Resource Management.	

Unit – II	**Contact Hours = 8 Hours**
Recruitment and Placement: Human Resource Planning and Recruiting, Recent trends of Recruiting, Employee Testing and Selection, Interviewing Candidates.	

Unit – III	**Contact Hours = 8 Hours**
Training and Development: Training and Developing Employees, Performance Management and Appraisal	

Unit – IV	**Contact Hours = 8 Hours**
Compensation: Pay Structure, Pay for Performance and Financial Incentives, Benefits and Services	

Unit – V	**Contact Hours = 8 Hours**
Employee Relations: Justice, and Fair Treatment in HR Management, Developing Employee Relations, Disciplinary procedure and Grievance Redressal, Employee Health and Safety	

Flipped Classroom Details

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

Unit No.	**Self-Study Topics**
1	**Evolution of HRM**
2	**Job Analysis**
3	**Strategic Pay Plans**
4	**POSH Act**

5	**Global HRM and its implications**

Books	
	Text Books:
1	Gary Dessler, Human Resource Management, Pearson Education
2.	Michael Armstrong, Stephen Taylor, Armstrong's Handbook of Human Resource Management Practice, Kogan Publication
3.	Robert Mathis and John Jackson, Human Resource Management, Cengage Learning,14th, 2016
	Reference Books:
1.	Bohlander, S. S. (2012). Managing Human Resources. Newyork : Thomson Learning
2.	Cynthia Fisher, S. (2008). Human Resource Management (Fifth ed.). New Delhi: Wiley Dreamtech
	E-resources
1.	Edx- People Management / https://www.edx.org/course/people-management-2
2.	NPTEL, Human Resource Management – I/ https://nptel.ac.in/courses/122105020

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	Students apply the models of human resource management	**L3**	**1,2**	**1**
2.	Students analyze of methods of human resource management and practices in the organizations	**L4**	**1,2**	**2**
3.	Students would be able to analyze & plan effective practices and policies of human resource management in the organizations	**L3**	**2.4,6**	**2**
4.	Students will be able to apply & evaluate good HR practices	**L4**	**2,4,6**	**3**

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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%.
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CO-PO Mapping (Planned)					CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO4**	**PO6**	**PSO1**	**PSO2**	**PSO3**
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	Knowledge of HR Policies and Practices	HRM Domain	HR, Executive, Talent Acquisition, HR Recruiter, HR Generalist

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ELECTRICAL ENERGY CONSERVATION AND AUDIT

Course Code	22EEOE755	**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 understand the concepts of energy scenario and energy conservation ACT-2001.
2.	To understand the concepts of energy management and audit.
3.	To understand the theory of energy efficiency in electrical systems.
4.	To understand the energy efficient technologies in electrical system.

Pre-requisites : Basics of electrical engineering and power system.

Unit – I	Contact Hours = 8 Hours
Energy Scenario: Renewable and non-renewable energy, Indian energy scenario, integrated energy policy, energy intensity on purchasing power parity, Energy sector reforms, energy and environment, energy security, energy conservation and its importance, Energy Conservation Act-2001 and its features.	

Unit – II	**Contact Hours = 8 Hours**
Energy Management & Audit: Definition, energy audit, need, types of energy audit and approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.	

Unit – III	**Contact Hours = 8 Hours**
Energy efficiency in Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement benefits, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. **Electric motors:** motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors**.**	

Unit – IV	**Contact Hours = 8 Hours**
Fans and blowers: Types, performance evaluation, efficient pumping system operation, flow control strategies and energy conservation opportunities. **Lighting System:** Introduction, Basic Parameters and terms in lighting system, Lighting source and lamp types, recommend illuminance levels for various tasks/activities/locations, methods of calculating illuminance-lighting design for interiors, general energy saving opportunities, energy efficient lighting controls standard and labeling programs for FTL lamps and lighting case study.	

Unit – V	Contact Hours = 8 Hours
Energy Efficient Technologies: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
1	Renewable and non-renewable energy, Indian energy scenario
2	Energy audit instruments
3	Electricity billing

Books	
Text Books:	
1.	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2.	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3.	S. C. Tripathy, —Utilization of Electrical Energy and Conservation‖, McGraw Hill, Reprint 1991
Reference Books:	
1.	W.R. Murphy&G. Mckey Butterworths, "Energy Management", New Age International Publishers, 2007
2.	Amit kumar Tyagi, Hand book on Energy Audit and Management, TERI (Tata Energy Research Institute).
3.	Rakosh Das Begamudre, Energy conversion systems, New Age International Publishers 10th Edition,2000
	E-resources:
1.	https://onlinecourses.nptel.ac.in/noc21_mm23/preview
2.	https://beeindia.gov.in/en/energy-auditors

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
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.	***Explain t***he concepts of energy Scenario and energy conservation Act.	Un	1,9,10,12	1,2
2.	***Describe*** the theory of energy management and audit.	Un	1,2,12	1,2
3.	***Explain*** the concepts of energy efficiency in electrical systems	Un	1,6,7,12	1,2

4.	***Explain and Analyze*** the different energy efficient technologies in electrical system.	An	1,6,7,12	1,2
5.	***Explain*** the various energy conservation and audit concepts and submit a report.	Un	1,6,7,12	1,2

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
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IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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.
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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	√					√	√					√	√	√		
5	√					√	√					√	√	√		
Tick mark the CO, PO and PSO mapping																

Sl no	Skill and competence enhanced after undergoing the course	Applicable industry sectors & domains	Job roles student can take up after undergoing the course
1	Students will be able to identify the various power losses in the given system	All industries include education institutes, malls, super markets etc..,	Energy Auditor and Energy manager
2	Suggest methods to plug the losses and increase the efficiency		
3	Identify the new methods for energy efficient technology		
4	Conduct the energy Audit		

Name and Signature of the faculty members involved in designing the syllabus

Name and signatures of faculty members verifying /approving the syllabus

SOLAR AND WIND ENERGY

Course Code	22EEOE756	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 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	2	2	2	2	2

Unit No.	Self-Study Topics
1	Earth Radiation Spectrum
2	Principle of conversion of solar radiation into heat
3	Solar cell fundamentals
4	History of Wind Energy
5	Environmental Aspects

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 Singh Solanki, "Solar Photovoltic technology and systems", PHI publication
	E-resources
1.	https://archive.nptel.ac.in/courses/103/103/103103206/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
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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

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CO-PO Mapping (Planned)										**CO-PSO Mapping (Planned)**						
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	Designing of Solar PV & Solar thermal systems	Solar industry EPC, R&D sector	Design & R&D Engineer
2	Designing of wind energy systems	Wind Energy EPC, R&D sector	Design & R&D Engineer

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

ELECTRIC VEHICLES

Course Code	22EEOE757	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 = 00 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the overview of electric vehicles with respect to Indian & global market.
2.	To understand vehicle fundamentals, architecture and configuration of electric vehicle.
3.	To understand the EV motor and battery fundamentals for determining the size and type for EV application.
4.	To understand the role and operation of BMS in EV

Pre-requisites: Fundamentals of electrical engg. and electric machines

Unit – I	Contact Hours = 8 Hours
Introduction to Electric Vehicle Technology: EV history, overview of electric vehicles in India and global scenario, importance of different transportation development strategies to future oil supply, EV benefits & challenges, comparison of process efficiency between ICE & electric vehicle	

Unit – II	Contact Hours = 8 Hours
Vehicle fundamentals and power trains: Longitudinal vehicle model, longitudinal resistance- aerodynamic drag, grading resistance, rolling resistance. total tractive force, maximum tractive effort and powertrain tractive effort, vehicle performance- maximum speed of a vehicle, gradeability, acceleration performance, braking performance and distribution, vehicle power plant and transmission characteristics	

Unit – III	Contact Hours = 8 Hours
Typical EV system- Types of electric vehicle-structure & operating principle of each type **EV Architectures and Configurations:** Architectural structures and configurations, major EV subsystems **Motors for EV:** Motor and engine ratings, EV and HEV motor requirements, types of EV motors-torque speed characteristics, important features & ratings, motor sizing & selection.	

Unit – IV	Contact Hours = 8 Hours
EV batteries: Battery parameters- cell and battery voltages, charge (or Amphour) capacity, cut off voltage, maximum charge voltage, open circuit voltage, terminal voltage, C-rating, specific energy, specific power, self-discharge rates. battery sizing for EV, types of batteries for EV-lead acid, nickel based, lithium based-important ratings & features, merits and demerits	

Unit – V	Contact Hours = 8 Hours
Battery Management System (BMS): Need of BMS, functions of BMS, structure of BMS, SOC, DOD, SOH, cell balancing using different static and active balancing techniques	

Flipped Classroom Details

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

Unit No.	Self-Study Topics
II	Vehicle Power Plant and Transmission Characteristics
III	Major EV subsystems
IV	Types of batteries for EV-Lead acid, Nickel based, Lithium based-important ratings & features, merits and demerits
V	Functions of BMS

Books	
	Text Books:
1.	Electric Vehicle Technology Explained, James Larminie, John Lowry, 2nd Edition, wiley publication ISBN: 978-1-119-94273-3, September 2012.
2.	Electric Vehicle Engineering, Per Enge, Nick Enge, Stephen Zoepf, McGraw Hill , 1st Edition 2021
	Reference Books
1.	Electric Vehicle Technology, Prof. Suresh Pawar, Notion Press, September 2021.
2.	Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC PRESS, Boca Raton London New York Washington, D.C.
	E-resources
1.	https://nptel.ac.in/courses/108106170
2.	https://nptel.ac.in/courses/108102121

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	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*** the terms related to vehicle fundamentals, architecture and configuration of electric vehicle.	Un	1, 12	1
2.	***Explain*** the battery parameters, function and operation of BMS.	Un	1, 12	1
3.	***Determine*** the parameters of battery and vehicle torque requirement.	Ap	2, 12	1, 2
4.	***Analyze*** the performance parameters/characteristics of different subsystems of EV for sizing and selection.	An	2, 12	1
5.	***Analyze*** the different cell balancing techniques.	An	2, 3, 6 10, 12	1, 3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive
-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	EV subsystem modelling, Battery sizing, parameter estimation	Automobile industry, Battery Manufacturing industry	EV/automotive engineer, R & D engineer, Battery/BMS engineer. Sales engineer

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IoT and Data Analytics

Course Code	22EEOE758	Course type	OEC	Credits L-T-P	3-0-0
Hours/week: L - T- P	3-0-0			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 00 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the basic principles of IoT, digitization and different IoT architectures.
2.	To understand and explain the smart objects, application of IoT in different industries.
3.	To understand, explain and apply Data and Analytics for IoT, IoT Physical Devices.
4.	To 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 OT, 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: 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 and agriculture.	

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, end device activation methods, activation by personalising (ABP) method and Over the air activation method (OTAA), 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, introduction to data analytics using machine learning.	

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 end points. **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

Unit No.	Self-Study Topics
3	End device activation methods, activation by personalising (ABP) method and Over the air activation method (OTAA)

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.
3.	Pradeeka Seneviratne, "Beginning LoRa Radio Networks with Arduino", APRESS.
	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
1.	https://onlinecourses.nptel.ac.in/noc24_cs115/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	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*** 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.	Un	2,9,10,12	3
3.	***Explain*** *and* ***analyze*** Data and Analytics for IoT, IoT Physical Devices	An	2,9,10,12	3
4.	***Design*** *and* ***explain*** different IoT platforms.	Ap	2,9,10,12	3

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

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

IA Test:
1. 10 marks questions in Part A of IA question paper should also include an OBE related question (max 2 marks).
2. Remaining 20 marks questions in Part B & C should be descriptive

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

Eligibility for SEE:
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE.
-Minimum score in CIE 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 three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, 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	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

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

INDIAN KNOWLEDGE SYSTEM

Course Code	22AECEE77	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 = 15Hrs; T = 0 Hrs; P =0 Hrs Total = 15 Hrs			CIE Marks	100
Flipped Classes content	03 Hours			SEE Marks	--

Course learning objectives	
1.	To understand the importance of ancient knowledge to a society and familiarize with vedas and vedangas
2.	To understand the concepts of science and technology in ancient India

Pre-requisites: Nil

Unit – I	Contact Hours = 5 Hours
Importance of ancient knowledge and IKS. IKS corpus – a classification framework, history and unique aspects of IKS. Introduction to vedas and vedangas, vedic life. Indian philosophical systems – development and unique features, vedic schools of philosophy. Panchatantra – puranas and itihasa as a source of wisdom.	

Unit – II	Contact Hours = 5 Hours
Foundational concepts for science and technology – importance & role of Sanskrit in Natural language processing, stages of speech in Sanskrit vocabulary, number system in India, salient features of numerical system- measurement for time, distance & weight.	

Unit – III	Contact Hours = 5 Hours
Science, Engineering and Technology in IKS – unique aspects of Indian Mathematics and astronomy, functions in Mathematics, historical development of astronomy, elements of Indian calendar. The rise and fall of great Indian technology, mining, metal working, alloys in India Irrigation practices and architecture in India	

Flipped Classroom Details

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

Books	
	Text Books:
1.	B. Mahadevan, V. R. Bhat and R. N. Nagendra Pavana, “Introduction to Indian Knowledge system - Concepts and Applications”, PHI, 2023

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 Assignments (OA)
4.	Online classes	4.	

Course Outcomes (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.	**Understand** the importance of ancient knowledge to a society and familiarize with vedas and vedangas	**Un**	**6,7**	**1**
2.	**Understand** the fundamental concepts of science and technology in ancient India	**Un**	**6,7**	**1**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two Assignments	Case study/Activity	Total Marks
Marks	30+30 = 60	10+10 =20	20	100

- Writing 2 IA tests are compulsory.
-Student should score minimum 40% of 100 marks to pass the course.

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						✓	✓						✓		

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Name & Signature of Faculty members verifying/approving the syllabus

RELAY AND HIGH VOLTAGE LAB

Course Code	22EEL78	Course type	PCCL	Credits L-T-P	0 - 0 - 1
Hours/week: L - T- P	0 - 0 - 2			Total credits	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			CIE Marks	50
Flipped Classes content	-			SEE Marks	50

Course learning objectives	
1.	To demonstrate an understanding of the basic principle and types of circuit breakers and relays
2.	To demonstrate & analyse the various breakdown processes of insulating media with HVAC & HVDC
3.	To demonstrate and analyze the field mapping

Required Knowledge of : Power system protection and HV Engineering

Lab Experiment – I	**Contact Hours = 2 Hours**
Characteristics of over current relay	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Characteristics of static relay	
Lab Experiment – 3	**Contact Hours = 2 Hours**
Characteristics of numerical relay	
Lab Experiment – 4	**Contact Hours = 2 Hours**
Fuse characteristics	
Lab Experiment – 5	**Contact Hours = 2 Hours**
Negative sequence relay	
Lab Experiment – 6	**Contact Hours = 2 Hours**
Breakdown strength of air for HVAC and HVDC	
Lab Experiment – 7	**Contact Hours = 2 Hours**
Flashover characteristics of uniform and non-uniform gaps for HVAC and HVDC	
Lab Experiment – 8	**Contact Hours = 2 Hours**
Breakdown strength of transformer oil	
Lab Experiment – 9	**Contact Hours = 2 Hours**
Relay coordination	
Lab Experiment – 10	**Contact Hours = 2 Hours**
Field mapping	

Books	
Text Books:	
1.	Sunil S Rao, "Switchgear and Protection, Khanna Publication, 14th Edition, Khanna Publishers, 1977
2.	Badri Ram and Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, 2013,TMH
3.	M.S.Naidu and Kamaraju, "High Volatge Engineering", 5th Edition, 1982, MHE(Ind).
4.	C.L.Wadhwa "High Volatge Engineering" , 3rd Edition, 2010, New Age International Private limited.
Reference Books:	
1.	Soni, Gupta, Bhatnagar, "A course in Electrical Power" , 9th Edition, 1987, Dhanpath Rai Publication
2.	E.Kuffel and W.S. Zaengl, High Voltage Engg fundamentals, 2nd Edition, 2000, Elsevier Press.
	E-resources
1.	https://nptel.ac.in/courses/108105167

Course delivery methods		Assessment methods	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
		4.	Lab Test
		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.	Demonstrate various power system protection schemes	Ap	1,6,9,10,12	1,2
2.	***Explain and demonstrate*** breakdown phenomena in gases and liquids	Ap	1,6,9,10,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expt	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

1. Conduction of the experiment: 15 marks + Viva voce: 5 marks
2. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks
3. Lab project/ Open ended expt: 10 marks
3. Lab Test: 15 marks

Eligibility for SEE:

1. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

CO-PO Mapping (planned)													CO-PSO Mapping (planned)			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
1	✓	✓				✓			✓	✓		✓	✓	✓		
2	✓	✓				✓			✓	✓		✓	✓	✓		
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	Power system Protection	Power sector	JE, Electrical Engineer
2	High Voltage Testing	High voltage, Testing	JE, Electrical Engineer

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