ESTD. 1939

KARNATAK LAW SOCIETY'S
GOGTE INSTITUTE OF TECHNOLOGY
"JNANA GANGA" UDYAMBAG, BELAGAVI-590008,
KARNATAKA, INDIA.
Approved by AICTE & UGC
Permanently Affiliated and Autonomous Institution Under
Visvesvaraya Technological University, Belagavi
www.git.edu

ESTD. 1979

2018-19 Scheme

Department: Electrical & Electronics Engineering

Programme: B.E.

5th & 6th Semester Syllabus & Scheme of Teaching and Examination

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding calibre, 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 mind-set.

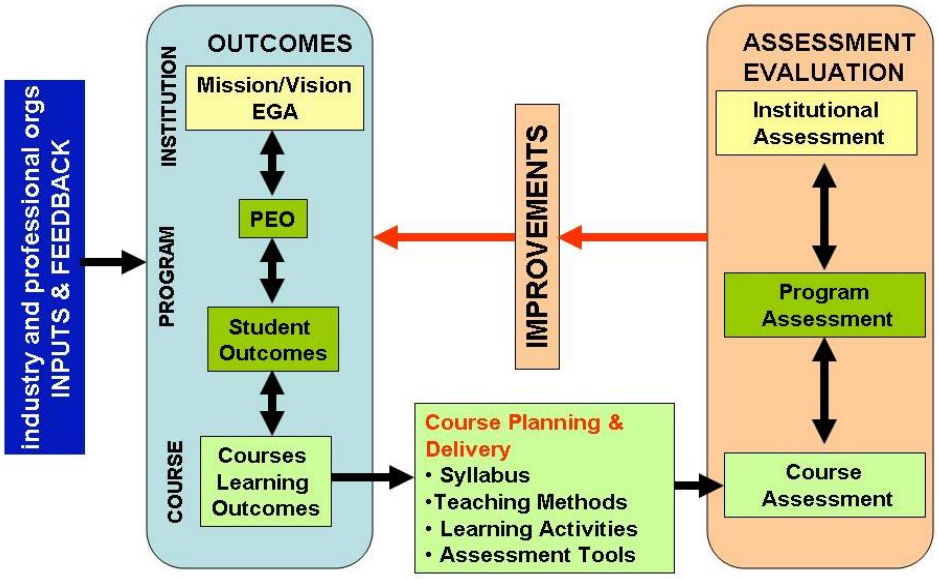
QUALITY POLICY

- 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 calibre 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.

OUTCOME BASED EDUCATION (OBE)



PROGRAM OUTCOMES(POs):

National Board of Accreditation (NBA) has framed the Program Outcomes (PO) based on twelve Graduate Attributes (GA). These POs are generic to engineering education and applies to all branches of Engineering.

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.

3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering 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 lifelong 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

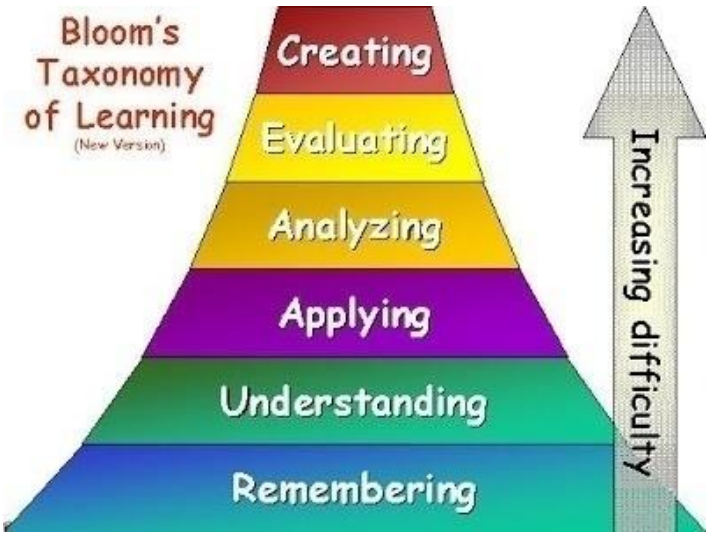
acquisition, data processing, automation and control applications and demonstrate capability to comprehend the technological advancements and usage of modern tools keeping up lifelong learning attitude.

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.

BLOOM'STAXONOMYOFLEARNINGOBJECTIVES

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 by BenjaminBloomandmodifiedduringthe1990's by a new group of cognitive psychologists, led by Lorin Anderson (a former student of Bloom's) to make it relevant to the 21st century. The **revised taxonomy** given below emphasizes what a learner "Can Do".

Lower order thinking skills (LOTS)		
L1	Remembering	Retrieve relevant knowledge from memory.
L2	Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.
L3	Applying	Carry out or use a procedure in a given situation – using learned knowledge.
Higher order thinking skills (HOTS)		
L4	Analyzing	Breakdown knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.
L5	Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.
L6	Creating	Combining or reorganizing elements to form a coherent or functional whole or into a new pattern, structure or idea.



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

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

(ii) Foundation Courses: The Foundation Courses are of two kinds:

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

The courses are: **Basic Science Courses (BS), Engineering Science Courses (ES)**.

Foundation Electives: These are value based courses aimed at man making education. The course is related to **Humanities and Social Science Courses (HS).**

(iii) Elective Courses: This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills.

An elective may be **Discipline Centric(PE)** or **Open Elective(OE).**

(iv) Mandatory Non-Credit Courses (MNC): These courses are mandatory for students joining B.E Program and students have to successfully complete these courses before the completion of degree.

Semester wise distribution of credits for B.E program

Total credits for B.E Program: 175 credits

		Regular batch		**Dip. Lateral entry**	
	Semester	**Credits per Sem**	**Total credits**	**Credits per Sem**	**Total credits**
1st year	1	20	40	----	----
	2	20		----	
2nd year	3	24	48	24	48
	4	24		24	
3rd year	5	24	48	24	48
	6	24		24	
4th year	7	23	39	23	39
	8	16		16	
	Total	**175**	**175**	**135**	**135**

Credit definition:

Lecture (L):One Hour /week – 1 credit
Tutorial (T): Two hour /week – 1 credit
Practical (P): Two hours /week – 1 credit

Scheme of Teaching and Examination- 5th and 6th Semester B.E.

Scheme of Teaching

Fifth Semester (Regular)									
S.No.	**Course Code**	**Course**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1	18EE51	Electrical Power Utilization, Estimation and costing	PC	4 – 0 - 0	4	4	50	50	100
2	18EE52	Power System Analysis	PC	3 – 0 -- 0	3	3	50	50	100
3	18EE53	Power Electronics	PC	3 – 2 - 0	5	4	50	50	100
4	18EE54	Microcontroller and Embedded Systems	PC	3 – 2 - 0	5	4	50	50	100
5	18EEPE55X	Professional Elective-I	PE	3 – 0 - 0	3	3	50	50	100
6	18EEOE56X	**Open Elective – I (Parent and Other Branch)**	OE	3 – 0 -0	3	3	50	50	100
7	18EEL57	EMD & CAED Lab	PC	0 – 0 – 3	3	1.5	25	25	50
8	18EEL58	Microcontroller and Embedded System Lab	PC	0 – 0 – 3	3	1.5	25	25	50
9		Employability Skills-I	HS	3 – 0 – 0	3	MNC	50	--	50
		Total			**32**	**24**	**400**	**350**	**750**

List of Professional Electives - I

S.No	Professional Elective I	
	Course Code	**Course Title**
1	18EEPE551	Fuzzy logic
2	18EEPE552	Modern Control Theory
3	18EEPE553	Design of Electrical machines
4	18EEPE554	Special Electrical Machines
5	18EEPE555	Electrical and Electronics Measurements

List of Open Electives -I

S.No	Open Elective-I	
	Course Code	**Course Title**
1	18EEOE561	Renewable Energy Sources
2	18EEOE562	Illumination Engineering
3	18EEOE563	PLC and Industrial Automation.
4	18EEOE564	Special Electric Machines
5	18EEOE565	Embedded Systems

Fifth Semester (Diploma)									
S.No.	**Course Code**	**Course**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1	18DMATEE51	Partial Differential Equations, Z-Transforms and Stochastic Processes **	BS	4 – 0 - 0	4	4	50	50	100
2	18EE52	Power System Analysis	PC	3 – 0 - 0	3	3	50	50	100
3	18EE53	Power Electronics	PC	3 –2- 0	5	4	50	50	100
4	18EE54	Microcontroller& Embedded Systems	PC	3 –2 - 0	5	4	50	50	100
5	18EEPE55X	Professional Elective-I	PE	3 – 0 - 0	3	3	50	50	100
6	18EEOE56X	**Open Elective – I (Parent and Other Branch)**	OE	3 – 0 - 0	3	3	50	50	100
7	18EEL57	EMD & CAED Lab	PC	0 – 0 – 3	3	1.5	25	25	50
8	18EEL58	Microcontroller and Embedded System Lab	PC	0 – 0 – 3	3	1.5	25	25	50
9	18EE59	Communicative English	HS	2 – 0 - 0	2	MNC	25	-	25
		Employability Skills-I	HS	3 – 0 – 0	3	MNC	50	--	50
		Total			**35**	**24**	**425**	**350**	**775**

**** One Course of 4 credits exempted in 5th sem for Diploma lateral entry students to maintain the same credits as regular.**

List of Professional Electives - I

S.No	Professional Elective I	
	Course Code	**Course Title**
1	18EEPE551	Fuzzy logic
2	18EEPE552	Modern Control Theory
3	18EEPE553	Design of Electrical machines
4	18EEPE554	Special Electrical Machines
5	18EEPE555	Electrical and Electronics Measurements

List of Open Electives -I

S.No	Open Elective-I	
	Course Code	**Course Title**
1	18EEOE561	Renewable Energy Sources
2	18EEOE562	Illumination Engineering
3	18EEOE563	PLC and Industrial Automation.
4	18EEOE564	Special Electric Machines
5.	18EEOE565	Embedded Systems

Sixth Semester									
S.No.	**Course Code**	**Course**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18EE61	Switchgear and Protection	PC	3 - 0 – 0	3	3	50	50	100
2	18EE62	Electric Drives and Traction	PC	3 – 2 – 0	5	4	50	50	100
3	18EE63	Advanced C and C++	PC	3 –2 – 0	5	4	50	50	100
4	18EE PE64X	Professional Elective-II	PE	3 – 0 – 0	3	3	50	50	100
5	18EE PE65X	Professional Elective-III	PE	3 – 0 – 0	3	3	50	50	100
6	18EE OE66X	**Open Elective – II (Other Branch only)**	OE	3 – 0 – 0	3	3	50	50	100
7	18EEL67	Power Electronics Lab	PC	0 – 0 – 3	3	1.5	25	25	50
8	18EEL68	Advanced C and C++Lab	PC	0 – 0 – 3	3	1.5	25	25	50
9	18EE69	Constitution of India, PE and HV	HS	2 – 0 – 0	2	1	25	25	50
10		Employability Skills-II	HS	3 – 0 – 0	3	MNC	50	--	50
		Total			**33**	**24**	**425**	**375**	**800**

List of Professional Electives –II

S.No.	Course code	Course Title
1	18EE PE641	Communications in Power System
2	18EE PE642	Reactive Power Management
3	18EE PE643	Testing and Commissioning of Electrical Equipment
4	18EE PE644	Field Theory
5	18EE PE645	Solar and Wind Energy

List of Professional Electives –III

S.No.	Course code	Course Title
1	18EE PE651	FACTS
2	18EE PE652	ANN and applications
3	18EE PE653	Electric and Hybrid Vehicles
4	18EE PE654	Advanced Power Electronics
5	18EE PE655	Electrical Engineering Materials

List of Open Electives -II

S.No.	Course code	Course Title
1	18EE OE661	Industrial Automation using IoT
2	18EE OE662	Electric Drives for industrial automation
3	18EE OE663	Electric and Hybrid Vehicles
4	18EE OE664	Fuzzy logic
5.	18EE OE665	Sensors & Transducers

V SEMESTER

Partial Differential Equations Z -Transforms and Stochastic Processes

(Diploma: Mech, Civ, E&C, E&E, Aero)

Course Code	18DMATEE51	**Credits**	4
Course type	BS	**CIE Marks**	50 marks
Hours/week: L-T-P	4–0– 0	**SEE Marks**	50 marks
Total Hours:	50	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Students should

1. Get acquainted with joint probability distribution
2. Study the concept of stochastic processes.
3. Understand the concept of partial differential equations
4. Apply partial differential equations to solve practical problems.
5. Study the concept of Z-transforms and its applications

Pre-requisites :

1. Partial differentiation
2. Basic probability, probability distributions
3. Basic integration

Unit – I **10 Hours**

Joint PDF: Discrete joint PDF, conditional joint PDF, expectations (Mean), Variance and Covariance.

Unit – II **10 Hours**

Stochastic Processes: Definition and classification of stochastic processes. Discrete state and discrete parameter stochastic process, unique fixed probability vector, regular stochastic matrix, transition probability, Markov chains.

Unit – III **10 Hours**

Partial Differential Equations: Formation of PDE by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration, solution of homogeneous PDE involving derivative with respect to one independent variable.

Unit – IV **10 Hours**

Applications of Partial Differential Equations: Derivations of one dimensional Heat and Wave equations. Solutions of one dimensional heat and wave equations. Solution of two dimensional Laplace equations by the method of separation of variables. Numerical solution of one dimensional heat and wave equations, two dimensional Laplace equation by finite differences.

Unit – V **10 Hours**

Z-Transforms: Definition, Z-transforms of standard functions, linearity, damping rule, shifting properties, initial and final value theorems with examples. Inverse Z-transforms and solution of difference equations by Z-transforms.

Books

Text Books:

1. B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012 and onwards.
2. Erwin Kreyszig –Advanced Engineering Mathematics, John Wiley & Sons Inc., 9th Edition, 2006 and onwards.
3. B. V. Ramana - Higher Engineering Mathematics, Tata McGraw-Hill Education Private Limited, Tenth reprint 2010 and onwards.

Reference Books:

1. P. N. Wartikar& J. N. Wartikar – Applied Mathematics (Volume I and II) Pune VidyarthiGrihaPrakashan, 7th Edition 1994 and onwards.
2. Peter V. O' Neil –Advanced Engineering Mathematics, Thomson Brooks/Cole, 7th Edition, 2011 and onwards.
3. Glyn James – Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, 2010 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Apply** joint probability distribution to solve relevant problems	L2
2.	**Apply** stochastic processes to solve relevant problems	L1, L2
3.	**Form** and **Solve** partial differential equations.	L1, L2
4.	**Develop** heat and wave equations	L2, L3
5.	**Apply** partial differential equations to solve practical problems.	L3
6.	**Apply** Z-Transforms to solve engineering problems.	L1, L2

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	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.	PO5

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessment Tests
2. Quiz
3. Assignments
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments /matlab/Scilab activity	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)

Semester End Examination (SEE):

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

ELECTRICAL POWER UTILIZATION, ESTIMATION AND COSTING

Course Code	18EE51	**Credits**	4
Course type	PC1	**CIE Marks**	50
Hours/week: L-T-P	4 – 0 - 0	**SEE Marks**	50
Total Hours:	50	**SEE Duration**	3 hours for 100 Marks

Course learning objectives

To impart an ability to the students,

1. To demonstrate an understanding of different types of electric heating and electric welding
2. To demonstrate an understanding of Laws of illumination, design of lighting schemes, different types of lamps and comparison
3. To demonstrate an understanding of refrigeration cycle and systems.
4. To demonstrate an understanding electrical Schedule, general idea about IE rule, Indian Electricity Act and major applicable I.E rules
5. To demonstrate an understanding general guidelines for wiring of residential and power installation
6. To demonstrate an understanding concept of service connection, classification and design of substations

Pre-requisites : Basic Electrical Engineering, Electrical Machines

Unit – I 10 Hours

a. Electric Heating: Modes of heat transfer, advantages and methods of electric of heating, resistance ovens, design of heating elements, failure of heating element, temperature control of resistance furnaces, induction heating, dielectric heating, the arc furnace, power supply and control, condition for maximum output, heating of building

b. Electric Welding: Electric welding, resistance and arc welding, control device and welding equipment, Ultrasonic welding, Electron beam welding

Self learning topics: Electric Welding

Unit - II **10 Hours**

a. Illumination: Laws of illumination, Types of lighting schemes, Design of lighting schemes, lighting calculation

b. factory lighting, flood lighting, street lighting, different types of lamps- incandescent, fluorescent, vapour, CFL and LED lamps and their working andcomparison of different types of lamps

Unit - III **10 Hours**

Refrigeration and Air Conditioning: Introduction, terminology, refrigeration cycle and systems, refrigerants, domestic refrigerators, water cooler, desert cooler, air conditioning, types of a.c systems, room air conditioning, central a.c systems, calculation of rating of electrical equipment

Introduction to Estimation and Costing: Introduction, 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 purchase enquiry and selection of appropriate purchase mode, comparative statement,general idea about IE rule, Indian Electricity Act and major applicable I.E rules

Unit - IV **10 Hours**

Internal Wiring: General rules guidelines for wiring of residential installation,Positioning of equipments, Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Load calculations and selection of size of conductor

Selection of rating of main switch, distribution board, protective switchgear ELCB and MCB and wiring accessories, Selection of type of wiring Rating of wires and cables Earthing of residential Installation ,Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation

Unit - V **10 Hours**

Service Connection and Power Installations: Concept of service connection, types of service connection and their features, method of installation of service connection, estimates of underground and overhead service connections, testing of wiring installations ,reason for excess recording of energy consumption by energy meter, general guidelines for motor installation wiring, determination of input power, current, rating of fuse, size of conduit and starter, design of workshop.

DesignandEstimation of Substations: Introduction, classification of substation, indoor substations, outdoor substations, selection and location of site for substation, main electrical connections, graphical symbols for various types of apparatus and circuit elements on substation main connection diagram key diagram of typical substations

Self learning topics: Design and Estimation of Substations

Text Books

1. **"Utilization of electric power and electric traction"** by J.B.Gupta, S.K.Kataria and sons publication
2. **"Utilization Of Electric Energy"** by Openshaw Taylor
3. **"Electrical Installation Estimating & Costing"** VIII Edition by J.B.Gupta, S.K. Katria& Sons New Delhi

Reference Books

1. **"A Course in Electrical Power"** Soni Gupta and Bhatnager-DhanapatRai& sons
2. **"Electrical Power"** by Dr.S.L.UppalKhanna Publications
3. **"Electrical Design Estimating and Costing"**, K.B.RainaS.K.Bhattacharya, New Age International
4. **"Electrical Wiring Estimating and Costing"**, Uppal, Khanna Publishers Delhi

Course Outcome (COs)

	At the end of the course, the student will be able to	Bloom's Level
1	**Explain** the different types of electric heating and electric welding	L2,L3
2	**Explain** Laws of illumination, Design of lighting schemes, different types of lamps and comparison	L2,L3
3	**Explain** the refrigeration cycle and systems	L2,L3
4	**Explain** the electrical Schedule, Catalogues, market Survey and source selection, recording of estimates, general idea about IE rule, Indian Electricity Act and major applicable I.E rules	L1,L2
5	**Explain** electrical Schedule, general idea about IE rule, Indian Electricity Act and major applicable I.E rules	L2,L3
6	**Explain** the concept of service connection, classification and design of substations	L2,L3

	Program Outcome of this course (POs)	**PO No.**
1.	Graduates will demonstrate knowledge of mathematics, science and engineering.	**PO1**
2.	Graduates will demonstrate the ability to identify, formulate and solve electrical and electronics engineering problems and also will be aware of contemporary issues.	**PO2**
3.	Graduates will develop confidence for self-education and ability for continuous learning.	**PO10**

Course delivery methods

1. **Black board teaching**
2. **PPT**

Assessment methods

1. **Assignment**
2. **Quiz**
3. **IA tests**
4. **Course Activity**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

POWER SYSTEM ANALYSIS

Course Code	18EE52	**Credits**	3
Course type	PC	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to:

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

Pre-requisites: Electrical machines, Power transmission & distribution

Unit – I 8 Hours

Representation of power system components: 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 8 Hours

Symmetrical faults: 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

Self learning topics: Rating and selection of Circuit Breakers

Unit – III 8 Hours

Symmetrical components: Introduction, analysis of unbalanced load against balanced Three-phase supply, neutral shift. Resolution of unbalanced phasors into their symmetrical components, phase shift of symmetrical components in star-delta transformer bank, power in terms of symmetrical components, analysis of balanced and unbalanced loads against unbalanced 3 phase supply, sequence impedances and networks of power system elements

(alternator, transformer and transmission line) sequence networks of power systems. Measurement of sequence impedance of synchronous generator.

Self-learning topics: Neutral shift and Measurement of sequence impedance of synchronous generator

Unit – IV **8 Hours**

Unsymmetrical faults: L-G, L-L, L-L-G faults on an unbalanced alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults in power system.

Unit – V **8 Hours**

Stability studies: Introduction, steady state and transient stability. Rotor dynamics and the swing equation, power-angle equation, equal area criterion for transient stability evaluation and its applications.

Self learning topics: Applications of EAC

Text Books

1. W.D.Stevenson, **"Elements of Power System Analysis",** TMH,4th edition.
2. I. J. Nagrath and D.P.Kothari, **"Modern Power System Analysis",** TMH, 3rd Edition, 2003.
3. K.Uma Rao, **"Computer Techniques and models in power systems",** I.K. International Publication.

Reference Books

1. Hadi Sadat, **"Power System Analysis",** TMH, 2nd Edition.
2. C.L.Wadhwa, **"Electrical Power system Analysis",** New Age publications.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Model** power systems & represent using line diagrams & impedance diagrams.	L1, L2, L3
2. **Explain** and **analyze** balanced and unbalanced systems, transients in power systems, symmetrical and unsymmetrical faults using symmetrical components and sequence networks.	L2, L3, L4
3. **Explain** and **analyze** steady state and transient state stability of power systems using Swing equation and Equal area Criterion.	L2, L4
4. **Determine** Short circuit fault current, Short circuit MVA, Rating of circuit breakers.	L5

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessment Tests& Quiz
2. Course Activity
3. Open Book Assignments
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

POWER ELECTRONICS

Course Code	18EE53	**Credits**	4
Course type	PC	**CIE Marks**	50
Hours/week: L-T-P	3 – 2 - 0	**SEE Marks**	50
Total Hours:	50	**SEE Duration**	3 Hour for 100 Marks

Course learning objectives

To impart an ability to the students to

1. Explain the characteristics and operation of power electronic devices used for conversion and control of electrical energy.
2. Design fundamental firing circuits and snubber circuits for power semiconductor devices.
3. Analyze the operation of power electronic converters used in different power conversion applications for different loads.
4. Evaluate the performance parameters of different power electronic converters.
5. Demonstrate an understanding of PE converters in industrial applications and UPS systems.
6. Explain fundamental commutation techniques and EMI associated with converters.

Pre-requisites: Basic Electrical Engineering, Analog Electronics.

Unit – I 10 Hours

Power semiconductor devices: Introduction to power electronics and power semiconductor devices, types of power semiconductor devices with typical ratings, control characteristics of power semiconductor devices, block diagram of typical PE converter system, advantages Types of power electronic converters.

Power transistors: Operation of power BJT as a switch, d**i**/dt and dv/dt limitations.

Gate drive and base drive circuits: Need of base drive circuit, types of base drive circuits for transistors. gate drive circuit for MOSFET, Isolation of gate and base drive circuits-need, types (using optocoupler and pulse transformer)

Self learning topics: gate drive circuit for MOSFET

Unit – II **10 Hours**

Thyristors: Introduction, two transistor model, characteristics-static and dynamic, di/dt and dv/dt protection, series and parallel operation of thyristors.

Thyristor firing circuits: design of thyristor firing circuit using UJT, microprocessor based SCR firing circuit (block diagram approach).

Commutation Techniques: types of commutation techniques, impulse commutation, complimentary commutation.

Unit – III **10 Hours**

AC voltage controllers: Introduction, principle of ON-OFF and phase control techniques, bidirectional controllers with resistive and R-L loads.

Electromagnetic compatibility: Introduction, effect of power electronic converters and remedial measures.

Controlled rectifiers: Single phase semi-converters, full converters, single phase dual converter, three-phase half-wave converters (mathematical derivation of expression for average and rms values of output voltage in all types rectifiers excluded. Numerical based on final expression for average and rms values of output voltages included).

self learning topics: three-phase half-wave converters

Unit – IV **10 Hours**

Choppers: Introduction, principle of step-down and step-up chopper with R and R-L loads, performance parameters, chopper classification.

Inverters: Introduction, principle of operation, performance parameters, single-phase bridge inverters. three phase inverters-180˚and 120˚ conduction modes, voltage control of single-phase inverters – single pulse width, multiple pulse width and sinusoidal pulse width modulation.

Self learning topics: pulse width modulation schemes

Unit – V **10 Hours**

Power electronics in industrial applications: Application power electronics in drives, electrolysis, welding, static VAR compensators, SMPS, HVDC power transmission, thyristorized tap changers.

Uninterrupted power supplies (UPS): UPS configurations-online or inverter preferred, offline or line preferred, offline interactive type,line interactive UPS systems, battery for UPS-capacity, efficiency, UPS calculations.

self learning topics: SMPS, UPS configurations

Text Books

1. M.H.Rashid, "Power Electronics", Pearson, 3rd Edition, 2006.
2. V. R. Moorthi, "Power electronics-devices, circuits and industrial applications", Oxford university press, first edition, fifteenth impression 2015.
2. R.S. Ananda Murthy and V. Nattarasu, "Power Electronics: A Simplified Approach", Pearson/Sanguine Technical Publishers.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, second edition.

Reference Books

1. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt. Ltd., Reprint 2010.
2. Ned Mohan, Tore M. Undeland, and William P. Robins, "Power Electronics – Converters, Applications and Design", Third Edition, John Wiley and Sons, 2008.
3. M. S. Jamil Asghar, "Power Electronics", Prentice Hall of India Private Limited, New Delhi, 2004.

E-Resources: https://nptel.ac.in/courses/108105066/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain the characteristics and operation of different power electronic devices.	L1, L2
2.	Design fundamental firing circuits and snubber circuits for SCR and power BJT.	L2, L3
3.	Analyze the operation of different power electronic converters for different loads and evaluate various performance parameters associated with it.	L2, L3, L4
4.	Explain commutation techniques for SCR and EMI associated with power electronic converters.	L1, L2
5.	Analyze the role of PE converters in industrial applications and UPS systems.	L2, L3

Program Outcome of this course (POs)	PO No.
1. Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4. Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	PO12

Course delivery methods

1. Black board teaching
2. Through PPT presentations

Assessment methods

1. Internal assessment and quiz
2. Open Book Assignments
3. Course seminar/project
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

MICROCONTROLLER AND EMBEDDED SYSTEMS

Course Code	18EE54	**Credits**	4
Course type	PC	**CIE Marks**	50
Hours/week: L-T-P	3-2-0	**SEE Marks**	50
Total Hours:	50	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives:

To impart an ability to the students to

1. Understand and explain 8051 Architecture and memory interfacing to 8051.
2. Explain and illustrate all the instructions of 8051 microcontroller instruction set & assembly language programming.
3. Describe and implement 8051 Timer/counter programming and basics of serial communication.
4. Explain and implement 8051 interrupts and interrupts programming. Understand and implement 8051 interfacing with LCD, DAC, Stepper motor and DC motor interfacing and programming.
5. Understand & explain embedded systems, types and explain ARM Cortex M3 processor.

Pre-requisites : Digital Electronics, C programming concepts

Unit – I 10 Hours

8051 Microcontroller basics: Inside the computer, Microcontroller processors. The architecture of 8051, PSW and flag bits, 8051 register banks and stack, internal memory organization of 8051, IO port usage in 8051, types of special function registers and their uses in 8051, pins of 8051, 8051/31 Interfacing with external ROM and RAM.

Self-learning topics: Microcontroller processors

Unit – II 10 Hours

a) Instruction set of 8051: Addressing modes, data transfer instructions, arithmetic instructions, logical instructions, and branch instructions, bit manipulation instructions, subroutine instructions and rotate instructions. JUMP and CALL program range, returns.

b) Assembly language programming in 8051: Assembler directives, introduction to 8051 assembly programming: assembling and running an 8051 program. I/O port programming. Time delay in 8051.

Unit – III 10 Hours

a) 8051 Timer programming in Assembly and C: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.

b) 8051 Serial port programming in assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C.

Unit – IV 10 Hours

a) 8051 Interrupt programming in assembly and C: 8051 interrupts, programming timer, external hardware, serial communication interrupt, interrupt priority in 8051, Interrupt programming in C.

b) Interfacing: LCD interfacing, DAC interfacing, Stepper motor interfacing, DC motor interfacing and PWM.

Unit – V 10 Hours

a) Introduction of embedded system: Introduction of Embedded System, Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of Embedded System.

b) ARM Cortex M3: Introduction, Features of Cortex M3 32-bit, applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers.

Text Books

1. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay, **"The 8051 Microcontroller and Embedded Systems, using assembly and C++",** PHI, 2006 / Pearson, 2006.
2. Kenneth J. Ayala Penram International, **"The 8051 Microcontroller Architecture, Programming & Applications",** 1996 / Thomson Learning 2005.
3. Shibu K V, **"Introduction to Embedded Systems"**, TMH Education, 2nd Edition.
4. Joseph Yiu, **"The Definitive Guide to the ARM Cortex-M3"**, 2nd Edition, Newnes, (Elsevier), 2010.

Reference Books

1. V.Udayashankar and MalikarjunaSwamy, **"The 8051 Microcontroller",** TMH, 2009.
2. Raj Kamal, **"Microcontrollers: Architecture, Programming, Interfacing and System Design",** Pearson Education, 2005.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Define** and **explain** the various blocks of microcontroller, **discuss** the various Microcontroller and Embedded processors, **discuss** and demonstrate memory interfacing to 8051.	L1, L2
2. **Explain** and **classify** 8051 instruction sets, make use of instruction sets for **develop**ing 8051 assembly language programs.	L2,L4
3. **Analyze** timers and counters of 8051 and **examine** the various modes used for programming and to **develop** simple programs, **explain** the necessity of serial communication and to develop programs for serial communication.	L2, L3, L4, L5
4. **Explain** the basic interrupt structure, summarize the various interrupts of 8051 and their functions, **and demonstrate** interrupt programming in assembly and C. De**velop** programs for Interfacing 8051 to LCD, DAC, stepper motor and DC motor with example.	L2, L3, L4
5. **Understand** Embedded system, its features, applications and advantages. **Describe** the architectural features, classification and application of 32-bit microcontroller ARM Cortex M3.	L2, L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **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.	PO5
4. **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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessment Tests& Quiz
2. Open Book Assignments
3. Course Activity
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

FUZZY LOGIC (ELECTIVE)

Course Code	18EEPE551	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives:

To impart an ability to the students to

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

Pre-requisites : Basic understanding of set theory

Unit – I 8 Hours

The mathematics of fuzzy control: Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle

Unit – II 8 Hours

Theory of approximate reasoning: Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference.

Unit – III 8 Hours

Fuzzy knowledge based controllers (FKBC): Basic concept of structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures.

Unit – IV 8 Hours

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

Unit – V 8 Hours

Adaptive fuzzy control: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria, set organizing controller model based controller.

Text Books

1. M Timothy John Ross, "Fuzzy Logic With Engineering Applications",Wiley,Second Edition, 2009.
2. G. J. Klir and T. A. Folger, "Fuzzy Sets Uncertainty and Information"**,** PHI IEEE, 2009.

Reference Books

1. D. Driankov, H. Hellendoorn and M. Reinfrank , "An Introduction to Fuzzy Control", Narosa Publishers India, 1996.
2. R. R. Yaser and D. P. Filer, "Essentials of Fuzzy Modeling and Control, John Wiley, 2007.

Course Outcome (COs)

At the end of the course, the student will be able to		**Bloom's Level**
1.	**Explain** the basic principles of crisp and fuzzy sets.	L2
2.	**Summarize** theory of approximate reasoning and justify the use of the rules.	L2
3.	**Analyze** and **summarize** the FKBC structure and understand the concept of fuzzification and defuzzification	L2,L4
4.	**Design** a typical fuzzy logic controller for various applications.	L2, L3, L5,L6
5.	**Understand** the concepts of adaptive mechanism for the fuzzy based controllers.	L2,L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
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.	2
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
5. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	9
6. **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.	10
7. **Project Management and Finance:** Demonstrate knowledge and understanding of 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.	11
8. **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.	12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessment Tests
2. Quiz
3. Assignments
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

MODERN CONTROL THEORY

Course Code	18EEPE552	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	**3 Hrs for 100 Marks**

Course learning objectives

To impart an ability to the students to

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

Pre-requisites: Matrix algebra, Laplace and inverse Laplace of standard functions. Control Systems.

Unit – I 8 Hours

State variable analysis and design: Introduction, concept of state, state variables and state model, state modeling of linear systems and linearization of state equation. State space representation using physical variables .

Unit – II 8 Hours

State space representation: using phase variables and canonical variables, derivation of transfer function from state model, diagonalization, Eigen values, eigen vectors, generalized eigen vectors. Matlab/Simulink simulations

Unit – III **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 **8 Hours**

Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design and design of state observer, concept of controllability & observability, methods of determining the same and duality principle. Matlab/Simulink simulations.

Unit – V **8 Hours**

Non-linear systems: Introduction, behavior of non-linear systems, common physical non linearity's saturation, friction, backlash, dead zone, relay, multi variable non-linearity.

Phase plane analysis: Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.

Self Learning Topics: Phase Plane Analysis

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: NPTEL online Course "**Advanced Continuous Control Systems with Matlab/Simulink"**

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Define** state and state variables. **Differentiate** the conventional control theory and modern control theory. Understand the modeling of physical systems. *Obtain* the state model using phase variables.	L2, L3
2. **Apply** the techniques used to convert the state space model into transfer function and **obtain** modal matrix to diagonalize the system.	L3, L2
3. **Explain** State transition matrix and **illustrate** the properties of state transition matrix.**Apply** the different methods to find the system response by constructing state transition matrix.	L3, L4
4. **Explain** concepts of controllability & observability with illustrations. **Design** of controller and observer by Transformation matrix, Direct substitution and Ackerman's formula.	L2, L6
5. **Define** non linear system. **Differentiate** linear and nonlinear Systems. Assess the stability of non linear systems by phase trajectory	L2, L 4

Program Outcome of this course (POs)	PO No.
1. Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
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.	2
3. 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.	5
4. 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.	12

Course delivery methods	Assessment methods
1. Chalk and Board	1. Open Book Assignments
2. Presentations	2. Internal Assessment Tests &Quizzes
3. Simulations	3. Course Seminar / Project (Mini project)
	4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

DESIGN OF ELECTRICAL MACHINES

Course Code	18EEPE553	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. Understand and apply the concepts of science of materials used in Electrical machines in design of Electrical machines
2. Understand and apply the concepts of magnetic circuits and thermal system in design of Electrical machines
3. Understand and apply the concepts of design of different types of transformers and assess compliance of requisite performance characteristics.
4. Understand and apply the concepts of design of 3 phase AC generators, DC motors and AC motors of different types and ratings .
5. Demonstrate an understanding of modern trends in design of Electrical machines

Pre-requisites: Basic Electrical Engineering, Electrical Machines

Unit - I — 8 Hours

PRINCIPLES OF ELECTRICAL MACHINE DESIGN: Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. Electromagnetic systems, heating & cooling, Modern trends in design of Electrical machines

Unit - II — 8 Hours

DESIGN OF TRANSFORMERS (Single phase and three phase)**:** Output equation for single phase and three phase transformer, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and cross sectional area of Primary and secondary coils, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular)

Unit - III **8 Hours**

DESIGN OF DC MACHINES: Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutators and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series and inter poles.

Unit - IV **8 Hours**

DESIGN OF INDUCTION MOTORS: Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring induction motor, estimation of No load current, leakage reactance, and circle diagram

Unit - V **8 Hours**

DESIGN OF SYNCHRONOUS MACHINES: Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non salient pole synchronous machines. Design of rotor of salient pole synchronous machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of rotor of non-salient pole machine

Self learning topics: Modern trends in design of Electrical machines

Text Books

1. **A Course In Electrical Machine Design**"- A.K.Sawhney,Dhanapat Roy and Sons
2. **Design Of Electrical Machines**- V. N. Mittle- 4/e edition, Standard Publications& Distributors

Reference Books

1. **Performance And Design Of AC Machine**s- M.G.Say, Paperback-2002
2. **Principles Of Electrical Machine Design-**R.K.Aggarwal, S.K.Kataria Publishers
3. **Design Data Handbook-**SanmugSundarm, New Age International Publishers

E-Resources: swayam.org

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain and apply the concepts of science of materials used in Electrical machines and the concepts of electromagnetic circuits and thermal system in design of Electrical machines	L3
2.	Explain and apply the concepts of design of different types of transformers to design and assess compliance of requisite performance characteristics.	L4
3.	Explain and apply the concepts of design for designing 3 phase AC generators, DC motors and AC motors of different types and ratings .	L4

	Program Outcome of this course (POs)	PO No.
1.	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineeringproblems.	1
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.	2
3.	Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3

Course delivery methods

1. Chalk and Board
2. PPT

Assessment methods

1. Internal Assessment Tests & Quiz
2. Open Book Assignment
3. Course Activity
3. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

SPECIAL ELECTRICAL MACHINES (ELECTIVE)

Course Code	18EEPE554	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives: To impart an ability to the students to

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

Pre-requisites : Basic Electrical Engineering, Electrical Machines

Unit - I **8 Hours**

Synchronous Reluctance Motors Constructional features–Types–Axial and Radial flux motors–Operating principles–Variable Reluctance and Hybrid Motors–SYNREL Motors–Voltage and Torque Equations- Phasor diagram - Characteristics.

Unit - II **8 Hours**

Stepping Motors Constructional features–Principle of operation–Variable reluctance motor – Hybrid motor–Single and multi stackconfigurations–Torqueequations–Modesofexcitations–Characteristics–Drive circuits–Microprocessor control of stepping motors–Closed loop control.

Unit - III **8 Hours**

Switched Reluctance Motors Constructional features–Rotary and Linear SRMs-Principle of operation–Torque production– Steady state performance prediction-Analytical method-Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Closed loop control of SRM - Characteristics.

Unit – IV **8 Hours**

Permanent Magnet Brushless D.C.Motors Permanent Magnet materials– Magnetic Characteristics –Permeance coefficient-Principle of operation–Types–Magnetic circuit analysis–EMF and torque equations –Commutation- Power controllers–Motor characteristics and control.

Unit – V **8 Hours**

Permanent Magnet Synchronous Motors Principle of operation–Ideal PMSM –EMF and Torque equations–Armature reaction MMF– Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics- Power controllers- Converter Volt-ampere requirements.

Text Books

1. E.G.Janardanan, "Special Electrical Machines", PHI, 2016
2. T.J.E.Miller,_Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press,Oxford, 1989.
3. T.Kenjo,_Stepping Motors and their Microprocessor Controls', Clarendon Press London, 1984.

Reference Books

1. R. Krishnan, Switched Reluctance Motor Drive-modeling,Simulation,Analysis,Designand Application',CRC Press,NewYork,2001.
2. P.P.Aearnley,_Stepping Motors–A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1 **Explain** principle of operation, construction and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors	L2,L3
2 **Understand** and **Explain** the performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors	L2,L3
3 **Understand** and **Demonstrate** the applications of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors and permanent magnet synchronous motors	L2,L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
2. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
3. **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.	PO5

Course delivery methods

1. Black board
2. PPT
3. Demo model

Assessment methods

1. IA test& Quiz
2. Course Seminar
3. OBA
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRICAL and ELECTRONIC MEASUREMENTS

Course Code	18EEPE555	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. Understand and explain fundamental units and dimensions and measurement of resistance, inductance, capacitance
2. Understand and explain extension of instrument ranges and instrument transformers
3. Understand and explain the methods of measurement of power , energy , frequency
4. Understand and explain working of Electronic voltmeters, CR Oscilloscope
5. Understand and explain basic concepts of transducers and data acquisition systems

Pre-requisites: Basic Electrical Engineering, Physics

Unit – I 8 Hours

Units and of fundamental and derived units: S.I. units. Dimensional equations, problems. Measurement of Resistance: Wheatstone's bridge, sensitivity, limitations Dimensions: Review. Kelvin's double bridge. Earth resistance, measurement by fall of potential method and by using Megger. Measurement of Inductance and Capacitance: Sources and detectors, Maxwell's inductance bridge, Anderson's bridge, Desauty's bridge, Shielding of bridges. Problems.

Unit – II 8 Hours

Extension of Instrument Ranges: Shunts and multipliers. Construction and theory of instrument transformers, Equations for ratio and phase angle errors of C.T. and P.T (derivations excluded).Turns compensation, illustrative examples (excluding problems on turns compensation), Silsbees's method of testing CT.

Unit – III **8 Hours**

Measurement of Power and Energy: Dynamometer wattmeter. UPF and LPF wattmeters, Measurementof real and reactive power in three-phase circuits. Induction type energy meter — construction, theory,errors, adjustments and calibration. Principle of working of electronic energy meter. Construction and operation of electro-dynamometer single-phase power factor meter. Weston frequency meter and phase sequence indicator.

Unit – IV **8 Hours**

Electronic Instruments: Introduction. True RMS responding voltmeter. Electronic multimeters. Digital voltmeters. Q meterDual trace oscilloscope — front panel details of a typical dual trace oscilloscope. Method of measuring voltage, current, phase, frequency and period. Use of Lissajous patterns. Working of a digital storage oscilloscope. Brief note on current probes.

Unit – V **8 Hours**

Transducers: Classification and selection of transducers. Strain gauges. LVDT. Measurement of temperature and pressure. Photo-conductive and photo-voltaic cells. Interfacing resistive transducers to electronic circuits. Introduction to data acquisition systems. Display Devices and Signal Generators: X-Y recorders. Nixie tubes. LCD and LED display. Signal generators and function generators

Text Books

1. Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney, Dhanpatrai and Sons, New Delhi.
2. Modern Electronic Instrumentation and Measuring Techniques, Cooper D. and A.D.Heifrick, PHI, 2009 Edition.

Reference Books

1. Electronic Instrumentation and Measurement, David A. Bell, oxford Publication ,2nd Edition, 2009.
2. Electrical Measurements and Measuring Instruments, Golding and Widdies, Pitman

E-Resources: swayam.org

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain fundamental units and dimensions and measurement of resistance, inductance, capacitance	L2
2.	Explain and apply extension of instrument ranges and instrument transformers	L2, L3
3.	Explain and apply the methods of measurement of power , energy , frequency	L2, L3
4.	Explain working of Electronic voltmeters, CR Oscilloscope	L2
5.	Explain basic concepts of transducers and data acquisition systems	L2

	Program Outcome of this course (POs)	PO No.
1.	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	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.	PO12

Course delivery methods

1. Chalk Board
2. PPT

Assessment methods

1. Internal Assessment test
2. Open book Assignment
3. Course Activity
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

RENEWABLE ENERGY SOURCES (ELECTIVE)

Course Code	18EE0E561	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Understand the aspects of the energy situation in India; identify the need and availability of renewable energy resources.
2. Understand and explain of the measurement of solar energy and technical and economic aspects of solar thermal energy.
3. Summarize different methods of extraction of solar energy and necessity of energy storage and methods of Energy Storage.
4. Explain concept of energy conversion process from biomass and construction of different biomass plants.
5. Analyze power availability in the wind and measurement and audit of wind energy and energy conversion.
6. Perform case studies of co-generation using biogases, rice husk, and roof top solar water heating systems.

Pre-requisites: Basic electrical engineering.

Unit – I 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 **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 **8 Hours**

Thermal systems: Principle of conversion of solar radiation into heat, solar water heaters (Flat Plate Collectors), solar cookers – Box type, concentrating dish type, solar driers, solar still, solar furnaces, solar green houses.

Biomass energy: Introduction, Photosynthesis process, biomass fuels, biomass conversion technologies, urban waste to energy conversion, biomass gasification, biomass to ethanol production, biogas production from waste biomass, factors affecting biogas generation, types of biogas plants – KVIC and Janata model; Biomass program in India.

Unit – IV **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, derivation for Power in the wind, wind site selection consideration, advantages and disadvantages of WECS**.**

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.

Unit – V **8 Hours**

Case studies: Cogeneration using bagasse - Combustion of rice husk, Roof top, Energy conservation in cooling towers and spray ponds, solar water heating.

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.

Course Outcomes (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Summarize** the energy sources of India and world. Outline the difference between conventional and non -conventional energy sources. Explain the energy consumption as a measure of prosperity. Definesolar constant, basic sun-Earth Angles and their representation and measurement of solar radiation data using Pyranometer and Pyrheliometer.	L1, L2
2. **Recognize** energy systems. Describe various forms of solar energy. Evaluatesolar thermal systems.	L4, L2
3. **Explain** Solar electric systems and different methods to store the solar energy. Describebiomass energy conversion system. Explain the different types of biogas plants	L2
4. **Analyze** the power available in the wind and the amount of power that can be extracted from the wind. **Explain** the process of conversion of wind power in to electric power.	L2,L4
5. **Support** case studies and write a report oncogeneration using bagasse - combustion of rice husk, roof top, Energy conservation in cooling towers and spray ponds, solar water heating.	L5

Program Outcome of this course (POs)	**PO No.**

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems. PO1

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. PO2

3. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice. PO6

4. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development. PO7

5. **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 PO12

Course delivery methods

1. Chalk Board
2. PPT

Assessment methods

1. Internal Assessment test
2. Open book Assignment
3. Course Activity
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ILLUMINATION ENGINEERING

Course Code	18EEOE562	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Study basics of lighting system and emerging light sources.
2. Understand components of lighting system.
3. Analyze energy efficient lighting.
4. Design interior and exterior lighting system.

Pre-requisites : Basic principles of lighting

Unit – I 8 Hours

Introduction of lighting System: Radiation and color, eye and vision, laws of illumination, illumination from point, line and surface sources, photometry and spectrophotometer, photocells, environment and glare, traditional light sources.

Unit – II 8 Hours

Advanced Light Sources: Comparative study of commercial CFLs, LEDs, electrical and optical properties, energy saving potential, LED drivers, intensity control techniques, Comparing LEDS with LASER, LEDs in communications, remote control.

Unit – III 8 Hours

Lighting System and its Components: Utility services for large building/office complex and layout of different meters and protection units. Different type of loads and their individual protections, selection of cable/wire sizes, wiring, switching and control circuits, potential sources of fire hazards and precautions, emergency supply – stand by and UPS.

Unit – IV **8 Hours**

Energy Efficient Lighting: Comparison between different light sources, comparison between different control gears, energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing), solar lighting schemes.

Unit – V **8 Hours**

Interior Lighting : Industrial, residential, office departmental stores, indoor stadium, theater and hospitals, specific design problems on this aspect.

Exterior Lighting: Flood, street, aviation and transport lighting, lighting for displays and signaling- neon signs, LED-LCD displays beacons and lighting for surveillance, specific design problems on this aspect.

Self learning topics: Flood and street lighting

Text Books

1. Joseph B. Murdoch , **"Illumination Engineering - from Edison's Lamp to the Laser",** Macmillan Publishing company, New York.
2. Gilbert Held, **"Introduction to light emitting diode technology and applications",** CRC Press.
3. E. Fred Schubart, **" Light emitting diodes",** Cambridge University Press.
4. NPTEL, Video lectures by Prof. N. K. Kishore, IIT Kharagpur.

Reference Books

1. **"BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting",**ManakBhavan, New Delhi.
2. **"IES Lighting Handbook",** (Application Volume 1987), Illuminating Engineering Society of North America
3. Butterworths and Stanley L. Lyons **"Handbook of Industrial Lighting",** Butterworth and Co. Publishers Ltd.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Explain** the concepts and components of Illumination system and **Select** proper light source for the given lighting application.	L2,L3
2. **Design** a lighting scheme for interior and exterior lighting.	L5
3. **Model** and **design** energy efficient lighting schemes.	L3, L4

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
2. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	PO6
3. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	PO7
4. **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.	PO12

Course delivery methods	**Assessment methods**
1. Lecture	1. IA test& Quiz
2. PPT	2. Open Book Assignment
	3. Course Activity
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

Course Code	18EEOE563	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE**	3 hours for 100 Marks

Course learning objectives

To impart an ability in the students to

1. Understand the basics of PLC, architecture, hardware and I/O devices.
2. Introduce and explain ladder programming, logic functions, latching, multiple outputs, functional blocks and emergency switches.
3. Understand the instruction list, sequential functions charts & structured text, subroutines**.**
4. Understand and explain different type of timers and counters, programming with timers and counters.

Pre-requisites : Logic design, control systems, basic programming concepts.

Unit – I **8 Hours**

Introduction: Introduction to programmable logic controller (PLC), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs I/O addresses.

Unit – II **8 Hours**

Programming: Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, program examples like location of stop and emergency switches.

Unit – III **8 Hours**

Programming methods: Instruction list, branch codes, sequential functions charts, branchingand convergence, actions, structured text, conditional and interaction statements, jump and call subroutines and examples**.**

Unit – IV **8 hours**

Internal relays: Relay programs, multiple input conditions, latch using relay, battery- backed relays, and one - shot operation, set and reset, master control relay.

Self learning topics: one - shot operation, set and reset, master control relay.

Unit – V **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, sequencer.

Text Books

1. W Bolton, **"Programmable Logic controllers",** 5th edition, Elsevier- newness.
2. John W. Webb, Ronald A Reis, **"Programmable logic controllers - principles and applications",** Pearson education, 5th edition, 2nd impression.

Reference Books

1. L. A Bryan, E. A Bryan, **"Programmable Controller Theory and Applications",** An industrial text company publication, 2nd edition.
2. E. A Paar, **"Programmable Controllers, An Engineers Guide",** Newness, 3rd edition.

Course Outcome (COs)

At the end of the course, the student will be able to		**Bloom's Level**
1.	**Explain** basics of PLC, advantages and disadvantages, internal architecture, hardware and I/O devices, signal conditioning, remote connections.	L2
2.	**Explain** and **Apply** ladder programming, logic functions, latching, multiple outputs, functional blocks and emergency switches.	L2, L3
3.	**Explain** instruction list, sequential functions charts & structured text, jump and call subroutines**.**	L2, L3
4.	**Develop** ladder programs, and explain battery- backed relays, and one - shot operation, set and reset of relay, master control relay.	L2, L3

5.	**Explain** and analyze different type of timers and counters, programming with timers and counters and their applications.	L2, L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
2.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
3.	**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.	PO5
4.	**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.	PO12

Course delivery methods	**Assessment methods**
1. Black board	1. IA test& Quiz
2. PPT	2. Course Activity
3. Demo model	3. OBA
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

SPECIAL ELECTRICAL MACHINES (ELECTIVE)

Course Code	18EEOE564	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

To impart an ability to the students to

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

Pre-requisites : Basic Electrical Engineering, Electrical Machines

Unit - I **8 Hours**

Synchronous Reluctance Motors Constructional features–Types–Axial and Radial flux motors–Operating principles–Variable Reluctance and Hybrid Motors–SYNREL Motors–Voltage and Torque Equations- Phasor diagram - Characteristics.

Unit - II **8 Hours**

Stepping Motors Constructional features–Principle of operation–Variable reluctance motor – Hybrid motor–Single and multi stackconfigurations–Torqueequations–Modesofexcitations–Characteristics–Drive circuits–Microprocessor control of stepping motors–Closed loop control.

Unit - III **8 Hours**

Switched Reluctance Motors Constructional features–Rotary and Linear SRMs-Principle of operation–Torque production– Steady state performance prediction-Analytical method-Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Closed loop control of SRM - Characteristics.

Unit – IV **8 Hours**

Permanent Magnet Brushless D.C.Motors Permanent Magnet materials– Magnetic Characteristics –Permeance coefficient-Principle of operation–Types–Magnetic circuit analysis–EMF and torque equations –Commutation- Power controllers–Motor characteristics and control.

Unit – V **8 Hours**

Permanent Magnet Synchronous Motors Principle of operation–Ideal PMSM –EMF and Torque equations–Armature reaction MMF– Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics- Power controllers-Converter Volt-ampere requirements.

Text Books

1. E.G.Janardanan, "Special Electrical Machines", PHI, 2016
2. T.J.E.Miller,_Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press,Oxford, 1989.
3. T.Kenjo,_Stepping Motors and their Microprocessor Controls', Clarendon Press London, 1984.

Reference Books

1. R. Krishnan, Switched Reluctance Motor Drive-modeling,Simulation,Analysis,Designand Application',CRC Press,NewYork,2001.
2. P.P.Aearnley,_Stepping Motors–A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1 **Explain** principle of operation, construction and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors	L2,L3
2 **Understand** and **Explain** the performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors	L2,L3
3 **Understand** and **Demonstrate** the applications of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C .motors and permanent magnet synchronous motors	L2,L3

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
2. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
3. **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.	PO5

Course delivery methods	**Assessment methods**
1. Black board	1. IA test& Quiz
2. PPT	2. Course Seminar
3. Demo model	3. OBA
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

EMBEDDED SYSTEMS

Course Code	18EEOE565	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to:

1. understand the concepts of Embedded system design such as ROM variants, RAM, SOC
2. understand the technological aspects of Embedded system such as signal conditioning, Sample & Hold.
3. understand the design tradeoffs.
4. study about the software aspects of Embedded system.

Pre-requisites: Digital Electronics, Basics of Microcontrollers

Unit - I **8 Hours**

Concept of Embedded System Design: Components, classification, skills required. Embedded Micro controller cores: Architecture of 6808 and 6811.Embedded Memories ROM variants, RAM.

Unit - II **8 Hours**

Technological Aspects of Embedded System: Applications of embedded system: Examples of Embedded systems SOC for bar code scanner. Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Sample & hold, multiplexer interface Internal ADC interfacing (excluding 6805 & 6812)

Unit - III **8 Hours**

Design Trade Offs Due to Process Incompatibility: Thermal Considerations

Data Acquisition System and Signal conditioning using DSP . Issues in embedded system design. Design challenge, design technology, trade offs.

Unit - IV **8 Hours**

Software aspects of Embedded Systems: Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, function queue-scheduling architecture.

Unit - V **8 Hours**

Subsystem interfacing: With external systems user interfacing, Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing.

Text Books

1 Valvano, J.W, **"Embedded Microcomputer systems : Real time interfacing"-** Brooks/Cole

2 Ganssle, Jack, "**The Art of Designing Embedded systems**"- Newness

3 Raj Kamal , **"Embedded System, Architecture, Programming and Design"-** TMH

Reference Books

1 Frank Vahid/Tony Givargis **, "A Unified Hardware/Software Introduction"-** Wiely student edition

2 Simon David, Embeded Software Premier, EddisonWessley

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Identify the Embedded system components and explain the architectures.	L1, L2
2.	Apply technological aspects to various interfacing devices & Elaborate various design tradeoffs. •.	L3, L2
3.	Apply software aspects and programming concepts to the design of Embedded System.	L3
4.	Explain the procedure to interface subsystems with external systems	L2

	Program Outcome of this course (POs)	PO No.
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	**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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessment Tests& Quiz
2. Course Activity
3. Open Book Assignments
4. Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks:100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRICAL MACHINE DESIGN & CAED LAB

Course Code	18EEL57	**Credits**	1.5
Course type	PC	**CIE Marks**	25
Hours/week: L-T-P	0 – 0 - 3	**SEE Marks**	25
Total Hours:	36	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

To impart an ability to the students to

1. Demonstrate an understanding of design of electrical machines in accordance with the specifications and preparation of design data sheet.
2. Develop computer aided drafting of front elevation, plan and side elevation half sectional views depicting all the relevant details of the parts of electrical machines as per the designed data sheet.
3. Perform drafting of single line diagrams of electrical power systems including generating stations and substations in accordance with the specifications.

List of experiments

1. Referring the specifications, design of 3 phase core type Distribution/ Power Transformer and drafting sectional Plan and Front elevation.
2. Referring the specifications design of 1 phase shell type Transformer and drafting sectional Plan and Front elevation.
3. Referring the specifications design of a DC machine and drafting sectional Plan and Front elevation.
4. Referring the specifications design of a 3 phase Squirrel cage Induction motor and drafting sectional Plan and Front elevation.
5. Referring the specifications design of a 3 phase AC generator and drafting sectional Plan and Front elevation.
6. Referring the specifications drafting of Single line diagrams for Generating stations and substations.

Books

1. S.F.Devalapur, **"Electrical Drafting" ,** EBPB Publications, Belgavi, 2016 Edition

   NewDelhi. 2006 Edition.

2. A.K.Sawhney, **"A course in Electrical Machine Design",** Dhanpat Rai & Co.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Demonstrate** understanding of constructional details of Electrical machines using computer aided drafting.	L2
2. **Design** and prepare design data sheet referring the specifications and **develop** sectional views of electrical machines.	L5,L6

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **Design solutions** for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4. **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.	PO5
5. **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	PO10

documentation, make effective presentations and give and receive clear instructions.

6. **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. PO12

Assessment methods

1. Conduction evaluation
2. Journal evaluation
3. Open end experiment
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

MICROCONTROLLER AND EMBEDDED SYSTEM LAB

Course Code	18EEL58	**Credits**	1.5
Course type	PC	**CIE Marks**	25
Hours/week: L-T-P	0-0-3	**SEE Marks**	25
Total Hours:	36	**SEE Duration**	3 Hours for 50 Marks

Course learning objectives

To impart ability in students to

1. Learn the assembly language programming using 8051.
2. Understand 8051 microcontroller and demonstrate data transfer.
3. Demonstrate operation of timers, serial/parallel ports, interrupts using 8051.
4. Understand and implement the I/O interfacing concepts for developing real time embedded systems.
5. Demonstrate working with Keil compiler and embedded C programming.

Pre-requisites : Digital Electronics, C Programming concepts

List of experiments

1. Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.
2. Arithmetic Instructions

   a. Addition/subtraction (8 bit & 16 bit)
   b. Multiplication and division (8 bit & 16 bit)

   c. Square of the data – (16 bits Arithmetic operations – bit addressable)
3. Counters, Boolean & Logical Instructions (Bit manipulations).
4. Using Cortex M3 LPC-1768 controller, write an ALP to perform:

   a. Addition of first ten numbers.

   b. multiplication of two numbers.
5. Controlling LED, Buzzer & Relay using Switch using Cortex M3 LPC-1768 Controller.

6. Use ARM Cortex M3 -32-bit controller to:

   a. Rotate DC motor in clockwise and anticlockwise.

   b. Rotate stepper in clockwise and anticlockwise.

7. Seven Segment LED display control using LPC-1768.
8. ARM Cortex M3 32- bit micro controller using LPC-1768 for External interrupt.
9. LCD display using ARM Cortex M3 32- bit micro controller (LPC1768).

Text Books

1. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; "The 8051 Microcontroller and Embedded Systems – using assembly and C", PHI, 2006 / Pearson, 2006.
2. Kenneth J. Ayala Penram International, **"The 8051 Microcontroller Architecture, Programming & Applications",** 1996 / Thomson Learning 2005.
3. **UM10360 LPC176x/5x User manual**, NXP Semiconductors 2014.

Course Outcome (Cos)

At the end of the course, the student will be able to	**Bloom's Level**
1. Utilize the assembly language programming using 8051.	L3
2. Demonstrate data transfer using 8051.	L2
3. Develop program to demonstrate operation of timers, serial/parallel ports, interrupts using 8051.	L2, L5
4. Implement the I/O interfacing concepts for developing real time embedded systems.	L3
5. Develop assembly program using Cortex M3 microcontroller.	L3

Program Outcome of this course (POs)	PO No.
1. Engineering Knowledge**:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4. 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.	PO5
5. 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.	PO10
6. 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.	PO12

Assessment methods

1. Conduction evaluation
2. Journal evaluation
3. Open end experiment
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

COMMUNICATIVE ENGLISH (For Diploma Students Only)

(Common to all branches)

Course Code	18EE59	**Credits**	MNC
Course type	HS	**CIE Marks**	25 marks
Hours/week: L-T-P	2-0-0	**SEE Marks**	NA
Total Hours:	30	**SEE Duration**	NA

Course learning objectives

1. To assist the students in developing necessary language skills in the areas like vocabulary, grammar, presentation and interactive communication.
2. To enable them to express their ideas coherently.
3. To help to comprehend and write effectively.
4. To aid them in understanding the importance of verbal and non-verbal communication.

Pre-requisites : Basic knowledge of English Language, Conversant with Basic English Grammar, Ability to frame sentence in English.

Unit – I: Grammar and Vocabulary 5 Hours

1. Frame grammatically acceptable sentences using Articles, Prepositions, Tenses, Modals and Subject-Verb agreement.

2. Enhance day to day general vocabulary and business vocabulary using every day words, appropriate collective nouns, idioms, phrases and phrasal verbs.

Self learning topics: Improve vocabulary by reading.

Unit – II: Reading Skills 5 Hours

1. Comprehend and interpret the texts such as notices, advertisements, memos, emails, charts etc. using reading techniques like skimming and scanning.

2. Using the knowledge of Phonetics to identify the right pronunciation from a dictionary.
3. Reading to enrich work place / business vocabulary.

Self learning topics: Solve reading assignments from Cambridge Business BENCHMARK Pre-intermediate to Intermediate.

Unit – III: Listening Skills **7 Hours**

1. Interpret recorded audio-video scripts in order to pick specific information in a short extract.
2. Listening exercises to understand factual information like dates, prices, telephone numbers etc.
3. Listening for gist (general meaning) to understand the speaker's opinions and pick out the specific information.

Self learning topics: Solve listening exercises

Unit – IV: Speaking Skills **8 Hours**

1. Interact effectively as an individual and also as a member in a team using correct grammar using wide range of vocabulary and avoiding common errors in English.

2. Design and formulate presentations using Microsoft PowerPoint and Non-Verbal communication cues (Kinesics, Proxemics, Chronemics and Paralingustics).

3. Speak in a logical way and speak for the right amount of time with proper pronunciation on general topics and business topics.

Self learning topics: Self evaluation by recording their speech.

Unit – V: Writing Skills **5Hours**

1. Write Business Letters, Emails, Memos and Notes using British English Standards/Etiquettes.

2. Writing skills using appropriate registers (formal and informal), correct grammar, correct spelling, vocabulary, linking words and phrases.

Self learning topics: Practice e-mail, memos, and report writing.

Books

1. Prof. M.B. Kudari, **"**Passage to English**"** Self Publication, Gokak, 2011.
2. T. M. Farhathulla, **"**Communication Skills for Undergraduates**"** - RBA-Chennai, 2006.
3. K.R. Lakshminarayanan, **"**English for Technical Communication**"**, Scitech-Chennai, 2002.
4. Prof. G.S. Mudambadithya, **"**Functional English**"**, Sapana- Bangalore,

5. Norman Whitby, **"**Cambridge English Business Benchmark**"**, Cambridge University Press, 3rd Printing 2014.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
Define various grammatical concepts such as Articles, Prepositions, Subject-Verb Agreement, and Tenses.	L1
Explain their ideas in their own words in English.	L2
Interpret the given information or data in the form of reading or listening materials.	L3

1.	***Distinguish*** among the various grammatical concepts like sentence patterns, sub-verb agreement, tenses etc.	L4
2.	***Evaluate*** the grammatically acceptable sentences, and ***Defend*** their view-points.	L5 L6
3.	***Design*** and ***Formulate*** oral and written presentations.	

	Program Outcome of this course (POs)	**PO No.**
1.	The course will help students to enhance their communicative skills and Business English.	PO8
	The course also helps the students to enhance their ability to work in a group.	PO7, PO9 PO11 PO10
2.		
3.	The course will encourage students to interact confidently and effectively.	
4.	The course will promote self learning.	

Course delivery methods	Assessment methods
1. Lecture	1. Individual speech
2. Learnsoft Software	2. PPT (Group activity)
3. PPT	3. Writing assignment
4. Vocabulary activities/games/videos	4. Online Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	**Individual activity - Speech**	**Group Activity – Power Point Presentation**	**Writing Skills – email/memo/letters**	**Online Test**	**Total**
Maximum Marks (25)	10	15	10	15	50

Continuous Internal Evaluation (CIE) is of 50 marks. It will be reduced to 25 marks for the calculation of SGPA and CGPA.

COURSE TITLE: EMPLOYABILITY SKILLS - I

Semester	V Semester	**Batch**	B.E/B.Tech
Course Code		**Credits**	MNC
Course Type	**HS**	**CIE Marks**	50 Marks
Hours/Week: L-T-P	3 – 0 – 0	**SEE Marks**	--
Total Hours	30 Hours	**SEE Duration**	--

Course Learning Objective

The course is designed to develop the employability skills of a student.

Syllabus

Module 1 **6 Hours**

***Quantitative Aptitude*:** Number System (3 Hours)

***Soft Skills*:** Body Language (1.5), Grooming and Etiquette (1.5)

Module 2 **6 Hours**

***Quantitative Aptitude*:** Ratio, Proportion & Partnership (1.5), Average (1.5)

***Logical Reasoning*:** Number Series (1)

Verbal Ability: Comprehension (2)

Module 3 **6 Hours**

***Quantitative Aptitude*:** Percentages (2)

***Logical Reasoning*:** Blood Relations (1), Letter Series (1)

Verbal Ability: Sentence Correction (2)

Module 4 **6 Hours**

***Quantitative Aptitude*:** Profit and Loss (2)

***Logical Reasoning*:** Seating Arrangement (1), Data Arrangement (1)

Verbal Ability: Ordering of Sentences (2)

Module 5 **6 Hours**

Quantitative Aptitude: Time & Work (2)

***Logical Reasoning*:** Analogy (1), Direction Sense Test (1.5)

***Soft Skills*:** Group Discussions (1.5)

Text Books:

1. How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.

2. How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.

3. 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.

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

Course Outcomes (Cos):

On completion of this course, students will be able to:

1. Clear the Aptitude round of recruiters during placements

2. Perform confidently during the GD and Interview process

3. Develop behaviors that are appropriate for a professional

Course Delivery Methods

- Black Board Teaching
- Power Point Presentation
- Class Room Exercise

Assessment Methods

- Internal Assessment Test
- Assignments
- Quiz
-

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two Online Tests	Class Participation	Total Marks
Maximum Marks: 50	25	15	10	50

- Writing two IA tests is compulsory
- **Minimum marks required to clear the subject: Minimum IA test marks (Average) 10 out of 25 AND total CIE marks 20**

VI SEMESTER

SWITCHGEAR AND PROTECTION

Course Code	18EE61	**Credits**	3
Course type	PC	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	**3 Hours for 100 Marks**

Course learning objectives

To impart an ability to the students to

1. To understand basics of Switches, Fuses Lightning arrestors and protective relaying.
2. To understand the fundamentals of CT, PT, PMU, IED and relays.
3. To demonstrate an understanding of Circuit Breaker concepts, working and CB Testing.
4. To understand Protection Schemes for Generator, Transformer and Induction Motor.

Pre-requisites: Fundamentals of Electrical Engineering, Power system basics, Electrical Machines.

Unit - I **8 Hours**

Overview of Electrical Energy system, (Switchyard, Substation) Need of Switchgear & Protection Systems, Apparatus and System Protection, Isolating switch, load breaking switch, Fuse, Fuse law, Fuse material, HRC fuse, Lightning arrestors.

Protective Relaying: Requirement of Protective Relaying, Zones of protection, Essential qualities of Protective Relaying, Classification of Protective Relays, Discrimination.

Unit - II **8 Hours**

Measuring and sensing devices: current transformer & potential transformer, Phasor measurement unit, Intelligent Electronics devices, Directional over current relays (Induction Type),Impedance relay, Reactance relay, Negative Sequence relay, Static Relays.

Unit - III **8 Hours**

Principle of AC Circuit breaking: Arc, Arc Initiation, Arc interruption, Arc interruption theories – Slepian's theory and Energy balance theory, Re striking voltage, recovery voltage, Rate of rise of Re striking voltage, Current chopping, Resistance switching.

Self learning topics: Nil

Unit - IV **8 Hours**

Types of circuit breakers: namely Air Circuit breakers, Puffer type of SF6 breaker and Vacuum Circuit breaker.

Testing of Circuit Breakers: TypeTest, Routine Test, Development Test and Reliability test, Commissioning Test, Short circuit Test Layout, Indirect and Direct Testing.

Unit - V **8 Hours**

Generator Protection - Merz price protection, stator and rotor faults, protection against– unbalanced loading, loss of excitation, over speeding.

Transformer Protection - Differential protection, differential relay with harmonic restraint, Inter turn faults

Induction Motor Protection- Protection againstPhase fault, Ground fault, single phasing, phase reversal, over load

Text Books

1. Sunil S.Rao**Switchgear & Protection**- -Khanna Publishers.
2. Badriram&ViswaKharma**Power System Protection & Switchgear**- -TMH.
3. Y G. Painthankar and S R Bhide **Fundamentals of Power System protection**- -PHI publication, 2007.

Reference Books

1. Soni, Gupta &Bhatnagar **, A Course in Electrical Power**- - Dhanapatirai. Publication
2. Ravindarnath& Chandra **Power System Protection & Switchgear**- New age Publications.

E-Resources: https://nptel.ac.in/courses/108/101/108101039/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain the basics of Switches, Fuses Lightning arrestors and protective relaying.	L2-L3
2. Explain the basics of CT, PT, PMU, IED, Over current, Impedance, Negative Sequence Relay and Static Relay.	L2-L3
3. Explain Circuit Breaker concepts namely arc, arc interruption theories, restriking voltage, Current chopping, and Resistance Switching etc., Types of circuit breakers and testing of circuit breakers.	L2-L4
4. Explain the Protection Schemes for Generator, Transformer and Induction Motor.	L2-L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.	2
3. **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**.**	6
4. **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.	10
5. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black board teaching
2. PPT's and Videos

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRIC DRIVES AND TRACTION

Course Code	18EE62	**Credits**	4
Course type	PC	**CIE Marks**	50
Hours/week: L-T-P	3-2-0	**SEE Marks**	50
Total Hours:	50	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to:

1. Describe and analyze the four quadrant operation of electric motor.
2. Understand and apply electrical braking of electric motor.
3. Understand and explain the technique of DC motor control using power electronic circuits.
4. Understand and apply the techniques of Induction motor control using power electronic circuits.
5. Explain the technical and operational aspects of electrical traction.

Pre-requisites: Electrical Machines, Power electronics

Unit – I **10 Hours**

Electrical Drives and Dynamics: Electrical Drives. Advantages of electrical Drives. Parts of electrical drives. Choice of electrical drive. Fundamental torque equation , Multi quadrant operation. Equivalent values of drive parameters. Components of load torque. Nature and classification of load torque. Steady state stability, Load equalization.

Unit – II **10 Hours**

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

Unit - III 10 Hours

DC Motor Drive: Speed control of separately exited DC motor using single phase fully controlled rectifier – single phase half controlled rectifier- 3 phase fully controlled rectifier- 3 phase half controlled rectifier, Chopper controlled DC drive.

Unit – IV 10 Hours

Induction Motor Drive: Operation with unbalanced source voltage and single phasing. Variable voltage, variable frequency control. Voltage source inverter control. Current source inverter control. Static rotor resistance control. Slip power recovery (staticScherbius drive), numerical

Unit - V 10 Hours

Electric Traction: Requirement of ideal traction. System of traction. Speed time curve. Tractive effort Co-efficient of adhesion. Selection of traction motor. Specific energy. Factors affecting specific energy consumption.

Self learning topics: Hybrid Vehicles.

Text Books

1. G.K. Dubey, “Fundamentals of Electrical Drives” , Narosa Publications.
2. S.L. Uppal “ Electrical Power” Khanna Publishers.

Reference Books

1. S.K. Pillai, “ First Course in Electrical Drives” TMH Publications.
2. N.K. De and P.K. Sen, “Electric Drives” , TMH Publication.

Course Outcome (COs)

	At the end of the course, the student will be able to	Bloom's Level
1.	Explain and analyze four quadrant operation of electric motor	L2, L4
2.	Explain and apply different methods of electrical braking of electric motor.	L2, L3
3.	Explain and apply the techniques of DC motor control using power electronic circuit.	L2, L3
4.	Explain and apply the techniques of induction motor control using power electronic circuit	L2, L3
5.	Explain and apply the technical and operational aspects of electrical traction.	L2, L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ADVANCED C AND C++

Course Code	18EE63	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	3-2-0	**SEE Marks**	50 marks
Total Hours:	50	**SEE Duration**	3 hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Realize the importance of modularization and develop an in-depth understanding of advanced C concepts like pointers, structures, unions and files.
2. Understand the three pillars of object oriented programming namely encapsulation, polymorphism and inheritance and emphasize their benefits in software development.
3. Develop programming and debugging skills.

Pre-requisites: Basics of C Programming.

Unit – I — 10 Hours

Introduction : Header files and compilation process

Functions: Designing structured programs, function in C, user defined functions, inter function communication, standard functions. Programming examples. Passing individual elements of array, passing the whole array, passing two dimensional arrays.

Unit – II — 10 Hours

Pointers: Introduction, pointers for inter function communication, pointers to pointers, arrays and pointers, pointers arithmetic and arrays, passing an array to a function, memory allocation functions, array of pointers, programming applications.

Structures and Unions: Enumerated data types, structures, unions, programming examples.

Unit – III — 10 Hours

Introduction: Basic concepts of OOP, benefits of OOP, object oriented languages, applications of OOP, procedure-oriented programming v/s object-oriented programming, sample C++ program, class specification, classes & objects, scope resolution operator, accessing members, defining member functions, data hiding and encapsulation, constructors, destructors, parameterized constructors.

Unit – IV — 10 Hours

Functions in C++: The main function, function prototyping, call by reference, return by reference, inline functions, overloading of functions, passing objects as arguments, returning objects, arrays of objects.

Unit – V **10 Hours**

Inheritance and Polymorphism: Introduction to inheritance and polymorphism, public and private inheritance. Operator overloading, overloading unary and binary operators. C++ Streams, I/O in C++.

Text Books

1. Behrouz A.Forouzan& Richard F.Gilberg, **"Computer Science-A structured Programming approach Using C",** CENGAGE learning, 3rd Edition and onwards.
2. E. Balaguruswamy, **"Object-Oriented Programming with C++" ,** Tata McGraw Hill 6th Edition and onwards.
3. Herbert Schildt, **"The Complete Reference C++",** 4th Edition, Tata McGraw Hill.

Reference Books

1. Robert Lafore ,**"Object-Oriented Programming in C++",** Fourth Edition, Sams Publications.
2. Stanley B.Lippmann, JoseeLajore, **"C++ Primer",** 4th Edition, Pearson Education.
3. YashavantKanetkar, **"Let us C",** 2nd Edition, BPB Publications.

Course Outcome (COs)	**Bloom's Level**
At the end of the course, the student will be able to	
1. **Analyze** given problem and develop the necessary programs using functions, pointers and structures.	L4
2. **Identify** and **explain** the necessity of Object Oriented Programming for software development.	L2, L3
3. **Design** and **develop** software programs using OOP concepts like Encapsulation, Polymorphism and Inheritance.	L3
4. **Design** and **develop** programs for various problems with the ability to debug and fix errors/bugs.	L3, L4

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	PO 1
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO 2
3. 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.	PO 5
4. 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.	PO 12

Course delivery methods(planned)	Assessment methods(planned)
1. Chalk and board	1. Internal Assessments and Quiz
2. PPT	2. Open Book Assignment
3. Video lectures	3. Course Activity
	4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

COMMUNICATION IN POWER SYSTEMS (Elective)

Course Code	18EEPE641	Credits	3
Course type	PE	CIE Marks	50
Hours/week: L-T-P	3-0-0	SEE Marks	50
Total Hours:	40	SEE Duration	3 Hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Explain the basics of digital communication system as applied to power system Engineering.
2. Understand how control stations are migrating from customized platform to standard platform for data acquisition, data transmission, data communication, data processing and data distribution.
3. Understand and describe about the present SCADA practice and fundamentals of integrating the new devices in system operation to make power system as a smart grid.

Pre-requisites: Power generation, transmission, distribution, power system analysis, analog and digital electronics.

Unit – I 8 hours

Power system automation: Overview of power system instrumentation, power system metering, power system measurements, states of power system, components of Energy control centre ECC, overview of important state estimator techniques, bad data handling, observability analysis and pseudo measurements, Phasor measurement units (PMU), Intelligent electronic devices, smart meters and integration of IEDs for achieving automation, review of SCADA scheme with MTU and RTU as a master slave arrangement.

Unit – II 8 Hours

Fundamentals of data communication: The emergence of data communication system, characteristics of data transmission circuits, transmission channel and data handling capacity, digital codes, error detection and control, guided and unguided transmission media.

Unit – III 4 hours

Data sets and interconnection requirements: Modem classification, modem interface, interconnection of data circuits to telephone lines.

4 Hours

Reference Models: Overview of OSI and TCP/IP reference models: Design issues of different layer.

Unit – IV **8 Hours**

Data mining techniques and its application in power industry: Introduction, fundamentals of data mining, correlation, classification and regression, available data mining tools, data mining based market data analysis, data mining based power system security assessment, case studies.

Unit – V **4 hours**

Grid computing: Introduction, fundamentals of grid computing, commonly used grid computing packages, grid computing based security assessment, grid computing based reliability assessment, grid computing based power market analysis, case studies.

4 hours

Information security management: Vulnerability in power systems, threats, attacks and risk. Information security models, Intrusion detection system, security standards and reference documents.

Text Books

1. Kennedy, Davis, **"Electronic Communication System",** 4th edition, TMH.
2. Allen Wood and Woollen berg, **"Power Generation, control and Operation"**
3. Krutz Ronald, **"Securing SCADA Systems",** 2nd edition, Wiley.

Reference Books

4. W Stalling**, "Data and Computer Communications",** 1/e, PHI.
5. Zhaoyang Dong, Pei Zhang et al, **"Emerging Techniques in Power System Analysis",** Springer. Chapter 3 and 4.

Course Outcome (COs)

At the end of the course, the student will be able to		**Bloom's Level**
1.	**Explain** the communication components, functions and protocols	L2
2.	**Describe** the significance of power system automation, ECC operation, Phasor measuring units with advanced metering schemes.	L2
3.	**Explain** and **illustrate** the need for automation of power system components.	L2
4.	**Discussapplications** of modern power system communication tools.	L3, L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	**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.	PO5
4.	**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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

REACTIVE POWER MANAGEMENT

Course Code	18EEPE642	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	**3 hours for 100 Marks**

Course learning objectives

To impart an ability to the students to

1. Understand and explain the importance and objectives of reactive power control in Electrical power systems
2. Understand and explain the factors associated with reactive power issues in Electrical power systems
3. Understand and explain the reactive power control devices
4. Understand and explain the different methods of reactive power control such passive and active compensators

Pre-requisites:Basic Electrical Engineering, Electrical power systems, Power electronics

Unit – I 8 Hours

Introduction to reactive power: Importance of reactive power control in EPS, Reactive power devices. Theory of Load Compensation Introduction- Requirement for compensation, Objectives in load compensation, Specifications of a load compensator, Power factor correction and voltage regulations in single phase system, Phase balancing and p. f. correction of unsymmetrical loads, Compensation in term of symmetrical component

(No derivations)

Unit – II 8 Hours

Reactive Power Control: Fundamental requirements in AC Power transmission, Fundamental transmission line equation, Surge impedance and natural loading, Voltage and current profiles of uncompensated radial and symmetrical line on open circuit, Uncompensated line under load, Effect of line length, Load power and p. f on voltage and reactive power. **(No derivations)**

Unit - III 8 Hours

Passive and active compensators Uniformly distributed fixed compensation, Passive shunt compensation, Control of open circuit voltage by shunt reactance, Reactance of shunt reactors, multiple shunt reactors along the line.Series compensation: Objectives and practical limitations, Symmetrical line with mid-point series capacitor and shunt reactor, Power transfer characteristics and maximum transmissible power for a general case, Fundamental concepts of compensation by sectioning. **(No derivations)**

Unit - IV 8 Hours

Principles of Static Compensation: Principle of operation of thyristor controlled reactor, Thyristors switched capacitor. Series Capacitors: Introduction, protective gear, reinsertion schemes, Varistor protective gear.

Unit - V 8 Hours

Synchronous Condenser: Introduction, Power system Voltage control, Emergency reactive power supply, Starting methods, starting motor, reduced voltage starting, static starting. Harmonics effects, resonance, shunt capacitors and filters, telephone interferences, Reactive Power Co-ordination, Reactive power management, transmission benefits, reactive power dispatch & equipment impact. **(No derivations)**

Text Books

1. Reactive power control in electric power systems, T. J. E. Miller, John Wiley & Sons NY 2009
2. Reactive Power Management, D. Tagare, TMH, 1st Edition, 2004.

Reference Books

1. Power System Stability and Control. Kundur, TMH, 9th reprint, 2007.
2. Power System Voltage Stability, Carson. W. Taylor, McGraw-Hill, Inc.

E-Resources: swayam.org

Course Outcome (COs)

	At the end of the course, the student will be able to	Bloom's Level
1.	Demonstrate an understanding of the importance and objectives of reactive power control in Electrical power systems	L2
2.	Identify and explain the factors associated with reactive power issues in Electrical power systems	L2,L3
3.	Demonstrate an understanding of principle and operation of the reactive power control devices	L2, L3
4.	Explain the different methods of reactive power control such passive and active compensators	L2

Program Outcome of this course (POs)

1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understandingof the limitations.	PO5
5.	**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.	PO12

Course delivery methods

1. Chalk Board
2. PPT

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS

Course Code	18EEPE643	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3Hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Describe the process to plan, control and implement commissioning of electrical equipment's.
2. Differentiate the performance, specifications of transformer and induction motor.
3. Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears
4. Identification of tools and equipment's used for installation and maintenance of electrical equipment.
5. Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.

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

Unit - I 8 Hours

Transformers:

- **a. Specifications:** Power and distribution transformers as per BIS standards.
- **b. Installation:** Location, Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Oil filtration unit, Drying of Windings.

Unit – II 8 Hours

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

Unit – III 8 Hours

Synchronous Machines:

a. **Specifications and Installation:** specifications as per BIS Standards, Installation-Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out.
b. **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 8 Hours

Induction Motor:

Specification and Installation: specification, Procurement, Duty, Installation of Induction motor (Foundation, shaft installation), Drying of windings.

Testing: Insulation test, measurement of winding resistance, High voltage test: IS 4029-1967, Load test, No load test, Temperature rise test, determination of efficiency, speed torque characteristics.

Maintenance: Troubles, causes and remedies in Induction motor, protection of Induction motor, maintenance procedure for induction motor.

Self learning topics: Maintenance

Unit – V 8 Hours

Switchgear and Protective Devices: Types of Circuit Breakers, Specification of High Voltage circuit breaker.

Tests on Circuit Breaker: Insulation resistance measurement, Impulse voltage test, short circuit testing station and short circuit test, HVDC circuit breaker, Maintenance of Circuit Breaker.

Self learning topics: Maintenance of Circuit Breaker.

Text Books

1. S.Rao. "Testing, Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publishers, 6thEdition, 19thReprint, 2015.
2. R.L.Chakrasali, "Testing and Commissioning of Electrical Equipment", Prism Books Pvt. Ltd.
3. S.K.Sharotri, "Preventive Maintenance of Electrical Apparatus", Katson Publishing House, 1stEdition, 1980.

Reference Books

1. "Handbook of Switchgears", BHEL, McGraw Hill, 1stEdition, 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: SWAYAM

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Describe the process to plan, control and implement commissioning of electrical equipments	L1,L2
2.	Differentiate the performance specifications of transformer and induction motor.	L2
3.	Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.	L3,L5
4.	Describe corrective and preventive maintenance of electrical equipment's	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	PO7
4. **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.	PO12

Course delivery methods

1. Lecture
2. PPT

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

FIELD THEORY

Course Code	18EE PE644	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives:

To impart an ability to the students to

1. Understand and explain Electric field and intensity with laws also study Laplace in field theory study.
2. Explain and illustrate point charge particle with density measure and applying it to the conductors, dielectric and capacitors.
3. Describe and implement steady magnetic field and magnetic forces on point charges.
4. Study of magnetic materials through its fundamentals and Explain inductance and time varying fields with laws.
5. Study and understand uniform plane waves and boundary conditions with its theorems.

Pre-requisites: Electrical Charge, Field and Intensity fundamentals, scalar & vector algebra.

Unit – I 8 Hours

a. Coulomb's Law and electric field intensity: Experimental law of Coulomb, Electric field intensity, Field due to continuous volume charge distribution, Field of a line charge.

b. Electric flux density, Gauss' law and divergence: Electric flux density, Gauss' law, Divergence, Maxwell's First equation (Electrostatics), vectoroperator and divergence theorem.

c.Poisson's and Laplace's equations: Derivations of Poisson's and Laplace's Equations, Uniqueness theorem, Examples of the solutions of Laplace's and Poisson's equations.

Unit – II **8 Hours**

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

b. Conductors, dielectrics and capacitance: Current and current density, Continuity of current, metallic conductors, Conductor properties and boundary conditions, boundary conditions for perfect Dielectrics, capacitance and examples.

Unit – III **8 Hours**

a. The steady magnetic field: Biot-Savart law, Ampere's circuital law, Curl, Stokes' theorem, magnetic flux and flux density, scalar and Vector magnetic potentials

b. Magnetic forces: Force on a moving charge and differential current element, Force between differential current elements, Force and torque on a closed circuit.

Unit – IV **8 Hours**

a. Magnetic materials and inductance: Magnetization and permeability, Magnetic boundary conditions, Magnetic circuit, Potential energy and forces on magnetic materials, Inductance and Mutual Inductance.

b. Time varying fields and Maxwell's equations: Faraday's law, displacement current, Maxwell's equation in point and Integral form, retarded potentials.

Unit – V **8 Hours**

a. Uniform plane wave: Wave propagation in free space and dielectrics, Poynting's theorem and wave power, propagation in good conductors – (skin effect).

b. Plane waves at boundaries and in dispersive media: Reflection of uniform plane waves at normal incidence, SWR, Plane wave propagation in general directions.

Text Books

1. **"Engineering Electromagnetics",** William H Hayt Jr. and John A Buck, Tata McGraw-Hill, 7th edition, 2006.

Reference Books

1. **"Electromagnetics with Applications",** John Krauss and Daniel A Fleisch, McGraw-Hill, 5th edition, 1999
2. **"Electromagnetic Waves And Radiating Systems".** Edward C. Jordan and Keith G Balmain, Prentice – Hall of India / Pearson Education, 2nd edition, 1968. Reprint 2002.
3. **"Field and Wave Electromagnetics",** David K Cheng, Pearson Education Asia, 2nd edition, - 1989, Indian Reprint – 2001.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Define** and **explain** the various laws related to electric field and intensity, **discuss** the various theorems with numerical, **discuss** and **demonstrate** use of Laplace transform in field theory.	L1, L3
2. **Explain** the study of charge particle in electric field and **demonstrate** conductors, dielectric and capacitance with respect to change particles.	L1,L2,L4
3. **Define, apply & Analyze** steady magnetic field with laws and **examine** the various scalar and vector magnetic potentials and also **analyze** & **study** magnetic forces between charges.	L2, L3, L4
4. **Study** magnetic materials and inductance and **Explain** the basic of magnetic materials, **study** and **apply** principles to time varying field with Maxwell's equations.	L2, L4,L6
5. **Explain** wave propagation fundamentals. **Describe** the plane wave nature at boundaries.	L1,L3, L4

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1

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.	PO2
3.	**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.	PO5
4.	**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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

SOLAR & WIND ENERGY

Course Code	18EEPE645	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. Understand the Fundamentals of Energy Science and Technology, Energy Storage
2. Explain Solar Energy Concepts
3. Understand the Solar Photovoltaic Systems
4. Summarize the Wind Energy Scenario
5. Understand and analyse Basic Components of a Wind Energy Conversion(WEC) System

Pre-requisites:

Unit - I 8 Hours

Fundamentals of Energy Science and Technology: Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India.

Energy Conservation and Efficiency: Introduction, Important Terms and Definitions, Important Aspects of Energy Conservation, Global Efforts, Achievements and Future Planning, Energy Conservation/Efficiency Scenario in India, Energy Audit, Energy Conservation Opportunities.

Energy Storage: Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices.

Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation

Unit - II **8 Hours**

Solar Energy-Basic Concepts (continued): 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.

Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers

Unit - III **8 Hours**

Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications

Unit - IV **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 **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

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. Shobh Nath Singh, "Non-Conventional Energy Resources", Pearson, 1st Edition 2015
2. S.P. Sukhatme, J.K.Nayak, "Solar Energy – Principles of Thermal Collections and Storage", Mc Graw Hill, 3rd Edition 2008
3. Ahmad Hemami, "Wind Turbine Technology", Cengage, 1st Edition 2012

E-Resources: Online video lectures from SWAYAM.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain the importance of the role of renewable energy, the concept of energy storage and the principles of energy storage devices.	L2
2.	Explain the concept of solar radiation data and solar PV system fabrication, operation of solar cell, sizing and design of PV system, summarize the process of harnessing solar energy and its applications in heating and cooling	L3, L2
3.	Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection.	L2, L3
4.	Summarize the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
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.	2
3. **Environment & Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7
4. **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.	12

Course delivery methods

1. Chalk and Board
2. Presentations
3. Simulations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

Flexible AC Transmission System

Course Code	18EEPE651	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. Demonstrate an understanding of the aspects of FACTS, its controllable parameters and transmission line characteristics.

2. Understand the basic types of controllers and concepts of various voltage sourced converters.

3. Describe objectives of shunt and series compensation

4. Understand and explain the shunt compensation operation.

5. Understand and explain the series compensation

Pre-requisites: Basic electrical, transmission and distribution, power electronics.

Unit – I **8 Hours**

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

Unit – II **8 Hours**

Voltage Source Converters: Basic types of FACTS controllers, benefits from FACTS controllers. Basic concept of voltage source converters, single phase and three phases full wave bridge converters, basic concept of current source converters.

Unit – III **8 Hours**

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

Unit – IV **8 Hours**

SVC and STATCOM: TSC –TCR, FC TCR operation, its VI characteristics. Basic operating principles of STATCOM, reactive power generation by synchronous compensator & VSC.VI and VQ characteristics of SVC and STATCOM.

Unit – V **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.

Text Books

1. "Understanding FACTS Devices" N.G. Hingorani and L.Guygi IEEE Press Publications 2000.

Reference Books

1. S.Rao, Khanna publishers, "EHV - AC, HVDC Transmission & Distribution Engineering", 3rd edition.

2. K.R. Padiyar, "FACTS - Controllers in Power Transmission distribution", New age publishers.

Course Outcome (COs)

	At the end of the course, the student will be able to	**Bloom's Level**
1.	Explain the aspects of FACTS and its controllable parameters	L2
2.	Describe basic types of FACTS controllers and their applications	L2
3.	Apply basic concepts of various voltage sourced converters.	L3
4.	Explain and select suitable configuration for the system from a list of shunt compensation circuits.	L2
5.	Explain and select suitable configuration for the system from a list of series compensation circuits.	L2

	Program Outcome of this course (POs)	PO No.
1.	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	PO7
4.	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.	PO12

Course delivery methods

1. Lecture
2. PPT

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ANN& it's APPLICATIONS

Course Code	18EEPE652	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	**3 Hours for 100 Marks**

Course learning objectives

To impart an ability to the students to

1. **Understand** and **Explain** the importance of ANN
2. **Classify** and **Explain** ANN
3. **Understand** and **Explain** the operation and utility different types of ANN
4. **Identify** the types of ANN for the given task and **Apply**

Pre-requisites: Numerical Techniques, Network Topology.

Unit – I 8 Hours

Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptrons, linear separability, perceptron training algorithm, guarantees of success, modifications.

Unit – II 8 Hours

Multiclass networks-I, multilevel discrimination, back propagation, setting parameter values, theoretical results. Accelerating learning process, application, Madaline adaptive multilayer networks.

Unit – III 8 Hours

Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner-take-all networks. Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition.

Unit – IV **8 Hours**

Associative models, Hop Field networks, brain state networks, Boltzmann machines, hetero associations. Optimization using Hopfiled networks, simulated annealing, random search, evolutionary computation.

Unit – V **8 Hours**

Applications of ANN. Case studies demonstrating all types of ANN.

Text Books

1. Elements Of Artificial Neural Networks –Kishan Mehrotra, C. K. Mohan, Sanjay Ranka, Penram, 1997
2. Artificial Neural Networks- R, Schalkoff, McGraw Hill, 1997.

Reference Books

1. Neural Network Design- Hagan, Demuth and Beale Cengage,2nd Edition

E-Resources: 1. NPTEL Resource, 2. IEEE Publications

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Understand** and **Explain** the importance of ANN	L2
2.	**Classify** and **Explain** ANN	L2,L3
3.	**Understand** and **Explain** the operation and utility different types of ANN	L3
4.	**Identify** the type of ANN for the given task and **Apply**	L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems**.**	1
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.	2
3. **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.	5
4. **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	12

Course delivery methods

1. Black board
2. PPT

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRIC AND HYBRID VEHICLES

Course Code	18EEPE653	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. **Understand** the working of Electric Vehicles and recent trends
2. **Analyze** different hybrid drive topology used for hybrid electric vehicles
3. **Analyze** different types of motors and its control topology used for hybrid electric vehicles
4. **Design** the drive system used for electric vehicles.
5. **Understand & explain** the types and control strategies of Battery's used for electric and hybrid vehicles.

Pre-requisites: Control Systems Engineering, Electrical Machines, Power Electronics.

Unit – I **8 Hours**

Introduction to Hybrid & Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, Types of Electric Vehicle in Use Today, Electric Vehicles for the Future

Self learning topics: Types of Electric Vehicle in Use Today, Electric Vehicles for the Future

Unit – II **8 Hours**

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit – III **8 Hours**

Electric Propulsion: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit – IV **8 Hours**

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit – V **8 Hours**

Batteries – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries. Battery management system.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

E-Resources: NPTEL

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Understand** working of Electric Vehicles and recent trends	L1, L2
2.	**Analyze** different hybrid drive topology used for hybrid electric vehicles	L3
3.	**Analyze** different types of motors and its control topology used for hybrid electric vehicles	L3
4.	**Design** the drive system used for electric vehicles.	L4
5.	**Explain** the types and control strategies of Battery are used for electric and hybrid vehicles.	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
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.	2
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
4. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	7
5. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	9
6. **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.	10
7. **Project Management and Finance:** Demonstrate knowledge and understanding of 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.	11
8. **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.	12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ADVANCED POWER ELECTRONICS

Course Code	18EEPE654	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3 – 0 - 0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

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

Pre-requisites: Power Electronics.

Unit - I 8 Hours

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

Self learning topics: merits and demerits of buck and boost converters

Unit - II 8 Hours

Switched mode DC-DC converters (continued): Buck-boost converter-detailed theory, working principles, CCM and DCM modes analysis, boundary between continuous and discontinuous conduction, output voltage ripple, Cuk converter- detailed theory, examples, applications, merits and demerits.

Switched Mode DC Power Supplies: Introduction, Linear power supplies, overview of switching power supplies: fly back converter - circuit operation and analysis, examples.

self learning topics: Linear power supplies

Unit - III **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.

self learning topics: AC power supplies

Unit - IV **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)

Self learning topics: ZCS resonant switch converters operation

Unit - V **08 Hours**

Power electronics in battery management systems: Application of power electronics in rechargeable batteries, battery charge management, cell balancing, SOA of battery.

self learning topics: cell balancing, SOA of battery

Text Books

1. M.H.Rashid, **"Power Electronics",** Pearson, 3rd Edition.
2. Ned Mohan, Tore M. Undeland, and William P. Robins, **"Power Electronics – Converters, Applications and Design",** Third Edition, John Wiley and Sons.
3. Daniel.W.Hart, **"Power Electronics"**, TMH, First Edition.
4. Hua Bai, Chris Mi, "Transients of Modern Power Electronics", John Wiley & Sons Ltd, first edition 2011.

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

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Analyze** the operation of different types of switched mode dc-dc converters in CCM and DCM modes and design the circuit parameters.	L2, L3,L4
2.	**Analyze** the operation of different types of dc-dc converters for power supply applications and determine the circuit parameters.	L2, L3, L4
3.	**Explain** high frequency inductor and transformer design for PE systems.	L2, L4
4.	**Explain** principle of ZVS and ZCS switching used for converters.	L1, L2
5.	Analyze role of power electronics in battery management systems.	L2, L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	**Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4.	**Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	PO12

Course delivery methods

1. Black board teaching
2. Through PPT presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

4. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
5. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
6. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting atleast one full question from each unit.

ELECTRICAL ENGINEERING MATERIALS

Course Code	18EEPE655	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to:

1. Demonstrate the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
2. Demonstrate the knowledge of superconducting materials and their applications

Pre-requisites: Basic Electrical Engineering, Electrical Power Systems, Engineering Physics

Unit – I 8 Hours

Introduction to Electrical and Electronic Materials: Importance of materials, Classification of electrical and electronic materials, Scope of electrical and electronic materials, Requirement of Engineering materials, Operational requirements of electrical and electronic materials, Classification of solids on the basis of energy gap, Products – working principle and materials, Types of engineering materials, Levels of material structure. Spintronics and Spintronic materials, Ferromagnetic semiconductors, Left handed materials. Conductors: Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect, Seebeck effect, Thomson effect, Wiedemann – Franz law and Lorentz relation, Problems .

Unit – II 8 Hours

Conductive Materials and Applications: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing. Dielectrics: Introduction to dielectric materials, classification ofdielectric materials, Dielectricconstant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.

Unit – III 8 Hours

Insulating Materials: Insulating materials and applications – Ceramic, Mica, Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural andsynthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum. Magnetic Materials: Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Para magnetism, Ferromagnetism, Ant ferromagnetism and the corresponding materials. Ferrimagnetisms and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss.

Unit – IV 8 Hours

Magnetic Materials (continued): Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials. Superconductive Materials: Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field

Unit – V 8 Hours

Plastics: Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic. Materials for Opto – Electronic Devices: Introduction, Optical phenomena, Reflection, Refraction, Transmittivity, Scattering, Optical absorption, Optical properties of non-metals, Optical properties of metals, Optical properties of semiconductors, Optical properties of insulators. Luminescence, Opto – Electronic devices, Photoconductivity, Photoconductive cell

Text Books

1 A.J. Dekker, “Electrical Engineering Materials”, Pearson, 2016

Reference Books

1 R.K. Shukla Archana Singh, “Electronic Engineering Materials”, Mc Graw Hill 2012

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain electrical and electronics materials, their importance, classification and operational requirement	L2
2.	Explain conducting, dielectric, insulating and magnetic materials used in engineering, their properties and classification.	L3
3.	Explain the phenomenon superconductivity, super conducting materials and their application in engineering.	L2
4.	Explain the plastic and its properties and applications.	L3

Program Outcome of this course (POs)		PO No.
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3.	**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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

INDUSTRIAL AUTOMATION USING IoT

Course Code	18EEOE661	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Demonstrate an understanding of the basic principles of IoT, digitization and different IoT architectures.
2. Understand and explain the smart objects.
3. Understand and explain application of IoT in different industries.
4. Design and demonstrate LoRaIoT platform.

Pre-requisites: Basics of sensors, Automation

Unit – I 8 Hours

Introduction to IoT: Basics of IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Unit – II 8 Hours

Engineering IoT Networks: Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Unit – III 8 Hours

IoT in Industry: Utilities, Smart and Connected Cities, Transportation, Public Safety.

Self learning topics: Transportation

Unit – IV **8 Hours**

Introduction to LoRa and LoRaWAN: LoRa Concepts, Amplitude Modulation, Frequency Modulation, Frequency Shift Keying, Chirp Spread Spectrum, LoRa Spread Spectrum Modulation, LoRa Applications, Network Coverage, Low-Power Wide Area Networks, LoRaWAN, Packet Forwarders, Hardware for End Devices, Hardware for Gateways, LoRaWAN Frequencies, LoRaWAN – Advantages and Features of LoRaWAN, Hands on experiments and case studies.

Unit - V **8 Hours**

LoRaWAN Specifications: Introduction to LoRa – Introduction to LoRaWAN – Difference between LoRa and LoRaWAN – LoRaWAN architecture - LoRaWAN Classes – Class A, Class B and Class C Devices.

Network and Application Server: Introduction to Network Server – Introduction to Application Server - End Device Types and States – Activation of ABP End Devices – Activation of OTAA End Devices – Received Signal Strength Indicator (RSSI) – Signal to Noise Ratio (SNR) – Open Source LoRaWAN Server Integration

Text Books

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,**"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things",** 1stEdition, Pearson Education (Cisco Press Indian Reprint). (**ISBN:** 978-9386873743).
2. Srinivasa K G, **"Internet of Things",** CENGAGE Leaning India, 2017.
3. PradeekaSeneviratne, "Beginning LoRa Radio Networks with Arduino", APRESS, 2019.

Reference Books

1. Raj Kamal, **"Internet of Things: Architecture and Design Principles",** 1st Edition, McGraw Hill Education, 2017. (**ISBN:** 978-9352605224)
2. Miguel de Sousa, "Internet of things with Intel Galileo", PACKT publishing

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Explain** and **apply** the basic principles of IoT, digitization and different IoT architectures.	L2, L3
2. **Explain and analyze** the smart objects.	L3, L4
3. **Explain and analyze** the application of IoT in different industries.	L2, L3
4. **Design, analyze** and **apply** an understanding of LoRaIoT platform.	L2, L3, L4, L5

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **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.	PO5
3. **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.	PO12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRICAL DRIVES FOR INDUSTRIAL AUTOMATION

Course Code	18EEOE662	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 hours for 100 marks

Course learning objectives

To impart an ability to the students to

1. Explain principles and types of electrical drives. Apply the thermal model of motors and select rating of motor for a drive.
2. Describe types of DC motors, performance, control and applications. Select the motor for a particular application.
3. Explain types of induction and synchronous motors, performance, control and applications. Select the motor for a particular application.
4. Illustrate special electric drives, performance, control and applications. Select the motor for a particular application.
5. Explain application of motors to specific industry.

Pre-requisites : Electrical machines, principles of energy conversion

Unit – I 8 Hours

Introduction to electrical drives and automation: Electrical drives**,** advantages of electrical drives, parts of electrical drives, choice of electrical drives, requirement of adjustable speed drives, AC and DC drives, thermal model of motor for heating and cooling, classes of motor duty, concept of automation

Unit – II **8 Hours**

DC motor drives: Types of DC motors and their performance characteristics, starting, braking and plugging, speed control, armature voltage control, Ward Leonard drives, motor control from power electronic circuits – single phase and three phase half controlled rectifier, multiquadrant operation, chopper controlled DC drives, applications and case studies

Unit – III **8 Hours**

Induction and synchronous motor drives: Types of three phase and single phase induction motors, torque speed characteristics, starting, braking and plugging, speed control using power electronic circuits, types of synchronous motors, starting, speed control, brushless DC motor drives, applications and case studies

Unit – IV **8 Hours**

Special electric drives: AC and DC servomotors, two phase and three phase AC servomotors, comparison of servomotors with conventional motors, linear induction motor, stepper motors and their types, important features, PMDC motors, PCB motors, brushless DC motors, permanent magnet AC motors, switched reluctance motors, operation and control requirements, applications and case studies

Unit – V **8 Hours**

Application of motors to specific industry: Drive considerations for textile mills, steel rolling mills, cranes and hoist drives, cement mills, sugar mills, paper mills, electric cars and robotic applications, applicable battery technology, case studies

Self learning topics: Batteries used for electric cars

Text Books

1. Gopal K. Dubey, **"Fundamentals of electrical drives",** Narosa publishing house pvt. Limited, New Delhi, second edition, 2001.

Reference Books

1. Vedam Subrahmanyam**, "Electric drives, concepts and applications",** TMH publishing company limited, New Delhi, 2009.

2. Ashfaq Hussein and Haroon Ashfaq, "Electric machines", Dhanpat Rai and company pvt. Limited, New Delhi, second edition, 2015.

3. Course material from NPTEL lectures and published papers

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Recall basic principles of electric motors explain the procedure of selecting rating of the motor for any application.	L1, L2
2. Classify DC motors, explain the torque speed characteristics and select a motor for an application justifying with case study.	L2, L5, L4
3. Classify induction and synchronous motors, explain the torque speed characteristics and select a motor for an application justifying with case study.	L2, L5, L4
4. Classify special electric motors, explain the torque speed characteristics and select a motor for an application justifying with case study.	L2, L5, L4

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **Design/ Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	PO3
4. **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.	PO12

Course delivery methods

1. Chalk Board

Assessment methods

1. Internal Assessments and Quiz

2. Power Point Presentations

2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

ELECTRIC AND HYBRID VEHICLES

Course Code	18EEOE663	**Credits**	3

Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. **Understand** working of Electric Vehicles and recent trends
2. **Analyze** different hybrid drive topology used for hybrid electric vehicles
3. **Analyze** different types of motors and its control topology used for hybrid electric vehicles
4. **Design** and Size the drive system used for electric vehicles.
5. **Understanding** the types and control strategies of Batteries used for electric and hybrid vehicles.

Pre-requisites: Control Systems Engineering, Electrical Machines, Power Electronics.

Unit – I **8 Hours**

Introduction to Hybrid & Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, Types of Electric Vehicle in Use Today, Electric Vehicles for the Future

Self learning topics: Types of Electric Vehicle in Use Today, Electric Vehicles for the Future

Unit – II **8 Hours**

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit – III **8 Hours**

Electric Propulsion: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit – IV **8 Hours**

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit – V **8 Hours**

Batteries – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries. Battery management system.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

E-Resources: NPTEL

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Understand** working of Electric Vehicles and recent trends	L1, L2
2.	**Analyze** different hybrid drive topology used for hybrid electric vehicles	L3
3.	**Analyze** different types of motors and its control topology used for hybrid electric vehicles	L3
4.	**Design** the drive system used for electric vehicles.	L4
5.	**Explain** the types and control strategies of Battery's used for electric and hybrid vehicles.	L2

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1

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.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
4.	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	7
5.	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	9
6.	**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.	10
7.	**Project Management and Finance:** Demonstrate knowledge and understanding of 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.	11
8.	**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.	12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity

4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

FUZZY LOGIC (ELECTIVE)

Course Code	18EEOE664	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50

Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives:

To impart an ability to the students to

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

Pre-requisites : Basic understanding of set theory

Unit – I **8 Hours**

The mathematics of fuzzy control: Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle

Unit – II **8 Hours**

Theory of approximate reasoning: Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference.

Unit – III **8 Hours**

Fuzzy knowledge based controllers (FKBC): Basic concept of structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures.

Unit – IV **8 Hours**

Simple applications of FKBC: washing machines, traffic regulations, lift control, aircraft landing Control, Water level control, temperature control, Maximum power point tracking for solar panel, antilock braking system, etc

Unit – V **8 Hours**

Adaptive fuzzy control: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria, set organizing controller model based controller.

Text Books

1. M Timothy John Ross, "Fuzzy Logic With Engineering Applications",Wiley,Second Edition, 2009.
2. G. J. Klir and T. A. Folger, "Fuzzy Sets Uncertainty and Information"**,** PHI IEEE, 2009.

Reference Books

1. D. Driankov, H. Hellendoorn and M. Reinfrank , "An Introduction to Fuzzy Control", Narosa Publishers India, 1996.
2. R. R. Yaser and D. P. Filer, "Essentials of Fuzzy Modeling and Control, John Wiley, 2007.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Explain** the basic principles of crisp and fuzzy sets.	L2
2. **Summarize** theory of approximate reasoning and justify the use of the rules.	L2
3. **Analyze** and **summarize** the FKBC structure and understand the concept of fuzzification and defuzzification	L2,L4
4. **Design** a typical fuzzy logic controller for various applications.	L5,L6
5. **Explain** the concepts of adaptive mechanism for the fuzzy based controllers.	L2,L3

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1

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.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
4.	**Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
5.	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	9
6.	**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.	10
7.	**Project Management and Finance:** Demonstrate knowledge and understanding of 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.	11
8.	**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.	12

Course delivery methods

1. Chalk Board
2. Power Point Presentations

Assessment methods

1. Internal Assessments and Quiz
2. Open Book Assignment
3. Course Activity

4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks: 100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

SENSORS AND TRANSDUCERS

Course Code	18EEOE665	**Credits**	3
Course type	OE	**CIE Marks**	50

Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to:

1. Understand the need of transducers, their classification, advantages and disadvantages.
2. Explain the working of different types of transducers and sensors.
3. Understand the recent trends in sensor technology and their selection
4. Understand the basics of signal conditioning and signal conditioning equipment.
5. Configure Data Acquisition System and handle data conversion and explain the basics of Data transmission and telemetry.
6. explain measurement of various non-electrical quantities

Pre-requisites: Basic Electrical & Electronics Engineering.

Unit – I **8 Hours**

Sensors and Transducers: Introduction, Classification of Transducers**,** Advantages andDisadvantages of Electrical Transducers, Transducers Actuating Mechanisms, ResistanceTransducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers,Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.

Unit – II **8 Hours**

Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, PneumaticSensors, Light Sensors, Tactile Sensors, Fibre Optic Transducers, Digital Transducers, Recent Trends- Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer,Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems

Unit – III **8 Hours**

Signal Conditioning: Introduction, Functions of Signal Conditioning Equipment, Amplification, Typesof Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronicAmplifiers.

Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of DataAcquisition System, Data Acquisition Systems, Data Conversion.

Self learning topics:--

Unit – IV **8 Hours**

Data Transmission and Telemetry: Data/Signal Transmission, Telemetry.

Measurement of Non – Electrical Quantities: Pressure Measurement.

Unit – V **8 Hours**

Measurement of Non – Electrical Quantities (continued): Temperature Measurement, FlowMeasurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes,and Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement ofAcceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power,Measurement of Liquid Level, Measurement of Viscosity

Text Books

1. R.K Rajput, "Electrical and Electronic Measurements and instrumentation", S.Chand, 3rd Edition 2013

Reference Books

1. J.B.Gupta, "A Course in Electronics and Electrical Measurements and Instruments", Katson Books, 13th Edition, 2008
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai, 2015

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Classify the transducers and explain the need of transducers, their classification, advantages and disadvantages.	L1, L2
2. Explain the working of various transducers and sensors and Outline the recent trends in sensor technology and their selection.	L2
3. Analyze the signal conditioning and signal conditioning equipments	L3
4. Illustrate different configuration of Data Acquisition System and data conversion, data transmission and telemetry.	L2
5. Explain measurement of non-electrical quantities -temperature, flow, speed, force, torque, power and viscosity.	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. **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.	PO12

Course delivery methods

1. Chalk Board

Assessment methods

1. Internal Assessments and Quiz

2. Power Point Presentations

2. Open Book Assignment
3. Course Activity
4. Semester end exam (SEE)

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/Course Project	Total Marks
Maximum marks:100 (To be scaled to 50)	30+30 = 60	20	20	100 (Scaled to 50 later)
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

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

POWER ELECTRONICS LAB

Course Code	18EEL67	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0 - 0 – 3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 hours for 50 marks

Course learning objectives

To impart ability in students to

1. Demonstrate an understanding of characteristics of SCR and MOSFET/IGBT.
2. Illustrate experimentally an understanding of SCR turn on circuits.
3. Demonstrate an understanding of speed control of DC motor.
4. Demonstrate an understanding of experimental determination of performance of various power electronic converters for different loads.
5. Demonstrate an understanding of commutation techniques of SCR.

Pre-requisites : Power Electronics

List of experiments

1. Static characteristics of SCR.
2. Static characteristics of MOSFET/IGBT.
3. SCR turn-on circuits using synchronized UJT relaxation oscillator and digital triggering circuits.
4. Single-phase fully controlled semi converter connected to Rand R-Lloads.
5. A.C. voltage controller to R-load (light dimmer circuit) and R-Lloads.
6. Speed control of a separately excited D.C. motor using an IGBT or MOSFET chopper.
7. MOSFET/IGBT based single-phase full-bridge inverter connected to R load.
8. Study of SCR commutation using self commutation and complimentary commutation techniques.

Text Books

1. M.H. Rashid, **"Power Electronics",** Pearson, 3rd Edition.
2. L. Umanand, **"Power Electronics Essentials and Applications",** Wiley India Pvt. Ltd.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Experimentally obtain the characteristics of SCR and MOSFET/IGBT.	L3
2. Illustrate the application of SCR triggering circuit for voltage control.	L3
3. Demonstrate speed control of DC motor using DC choppers.	L3
4. Analyze the performance of power electronic converters experimentally.	L4
5. Demonstrate an understanding of commutation techniques of SCR.	L4

Program Outcome of this course (POs)	PO No.
1. Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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.	PO2
3. Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	PO4
4. 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.	PO5
5. 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.	PO10
6. Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	PO12

Assessment methods

1. Conduction evaluation
2. Journal evaluation
3. Open end experiment
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

ADVANCED C AND C++LAB

Subject Code	18EEL67	**Credits**	1.5
Course Type	L2	**CIE Marks**	25
Hours/week: L – T – P	0 – 0 – 3	**SEE Marks**	25
Total Hours:	36	**SEE Duration:**	3 hours for 50 marks

Course learning objectives

To impart an ability in students to

1. Analyze problem statement and design the solution for a given problem and develop a well documented C/C++ program.
2. Get acquainted with advanced concepts like Pointers and dynamic memory management and apply these concepts for building efficient programs.
3. Select appropriate data types and data structures for developing programs to address real world situations.
4. Apply OOP concepts namely developing, encapsulation, polymorphism and inheritance for writing efficient C++ programs.
5. Perceive programming and debugging skills.

List of experiments

1. Write a C program to read, print, transpose and multiply a given two dimensional matrices using functions. Function modules with matrices as arguments are

   - READ_MAT
   - PRINT_MAT
   - TRANS_MAT
   - MULT_MAT

   The program should check the condition for multiplication.

2. Implement a simple calculator application in C. Include the modules for following

   (i) Read the two numbers and the operation(+,-,*,/)
   (ii) Modules for addition, subtraction, multiplication and Division.
   (iii) Display the results.

   Use pointers to functions for add, subtract, multiply and divide operations.

3. Implement a simple banking application in C by making use of array of Structures. Include the modules to

   (i)Create a new account

   (ii)Deposit amount

(iii)Withdraw amount

(iv)Balance Enquiry

4. Write and execute a C++ program to read n students details-Name, USN,and marks in 3 subjects. Calculate and display the total, percentage and grade obtained for each student. Refer the following table for grading.

rade is A

ıd <80 grade B

d <70 Grade C

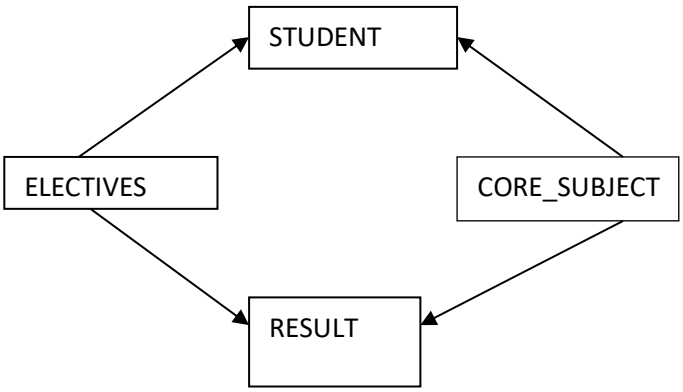
Create a student class; initialize the student details using constructors.

5. Write and execute C++ program with function overloading to calculate the area of a circle, rectangle, and a triangle.

6. Write and execute a C++ program to implement the COMPLEX number class and perform the following operations.

    1. Read a COMPLEX number.
    2. Display a COMPLEX number
    3. Add 2 COMPLEX numbers (use objects as function arguments)
    4. Add an integer number to one of the COMPLEX number

7. Write a C++ program for hybrid inheritance as shown



There is a class called student. It gets and prints Roll number and USN of students. There are two classes called Electives and core-subject which hierarchically inherit from the

base class called student. The class called electives gets and prints the marks of two elective subjects. The class called core subject gets and prints marks of three core subjects. Result is a class which has multiple inheritance from the classes Electives and core subject. The class called result declares the final result as passed if a student secures marks >=40 in all the five subjects.

8. Write a C++ program to illustrate the passing of objects as arguments. The user should input two different times in hours and minutes. The program should find the sum of the two times and display the result in hours and minutes.

Text Books

1. Behrouz A.Forouzan& Richard F.Gilberg, **"Computer Science-A structured Programming approach Using C",** 3rd Edition, CENGAGE learning.
2. E. Balaguruswamy, **"Object-Oriented Programming with C++",** Tata McGraw Hill – 6th Edition.
3. Herbert Schildt, **"The Complete Reference C++",** 4th Edition, Tata McGraw Hill.

Reference Books

1. Stanley B.Lippmann, JoseeLajore: C++ Primer, 4th Edition, Pearson Education.
2 YashavantKanetkar: Let us C, 2nd Edition, BPB Publications.

Course Outcome (COs)

At the end of the course, the student will be able to		**Bloom's Level**
1.	**Design** and **develop** a program in C/C++ to solve simple and complex problems.	L3
2.	**Illustrate** the use of pointers and dynamic memory management for developing efficient programs.	L2,L3
3.	**Examine and analyze** problem statement so as to select appropriate data types and data structures for developing program to address real word situations.	L4
4.	**Illustrate** the use of encapsulation, polymorphism and inheritance for building efficient C++ programs.	L2
5.	**Perceive** the skills required to design, develop & debug C/C++ program.	L3

Program Outcome of this Course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	PO1
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	PO2
3. **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.	PO5
4. **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.	PO10
5. **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.	PO12

Assessment methods

1. Conduction evaluation
2. Journal evaluation
3. Open end experiment
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN VALUES

Course Code	18EE69	**Credits**	1
Course type	HS	**CIE Marks**	25
Hours/week: L-T-P	2-0-0	**SEE Marks**	25
Total Hours:	30	**SEE Duration**	2 Hours

Course learning objectives

1. To provide basic information about Indian Constitution.
2. To identify individual role and ethical responsibility towards society

Pre-requisites : English Language, Social Studies

Unit – I Human Values 8 Hours

Chapter 1: Objectives, Morals, Values, Ethics, Integrity, Work ethics, Service learning, Virtues, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage ,Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Challenges in the work place, Spirituality.

Unit – II Professional Ethics 10 Hours

Chapter 2: Engineering Ethics: Overview, senses of engineering ethics, variety of moral issues, types of enquiries, moral dilemma, moral autonomy, moral development (theories), consensus and controversy, profession, models of professional roles, responsibility,

Chapter 3:

Theories about right action (ethical theories), self-control, self-interest, customs, religion, self-respect, case studies (Choice of the Theory), engineering as experimentation, engineers as responsible experimenters.

Chapter 4: Codes of ethics, Environmental ethics, Computer ethics, Engineers as managers, Ethics and code of business conduct in MNC.

12 Hours

Unit – III Constitution of India

Chapter 5: Introduction to Constitution of India- Formation and Composition of the Constituent Assembly –Salient features of the Constitution- Preamble to the Indian Constitution-Fundamental Rights- Fundamental Duties - Directive principles of state policy.

Chapter 6: Parliamentary system of governance-Structure of Parliament- Loksabha and Rajyasabha- Functions of Parliament- Legislative, Executive, Financial functions, Powers of Loksabha and Rajyasabha- Procedure followed in parliament in making law- Lokpal and functionaries.

Structure of union executive- Power and position of President, Vice President, Prime Minister and council of Ministers. Structure of Judiciary- Jurisdiction and functions of Supreme Court, High Court and subordinate courts.

Chapter 7: Federalism in Indian Constitution, Division of Powers- Union List, State List and Concurrent List, Structure of State legislation, Legislative Assembly and Legislative Council, Functions of State legislature, Structure of State Executive- Powers and positions of Governor, Speaker, Deputy Speaker, Chief Minister and Council of Ministers.

Local self government- meaning- Three tier system- Village Panchayat- Taluka Panchayat-Zilla Panchayat- Local Bodies- Muncipalities and Corporations, BruhathMahanagaraPalike. Functions of Election Commission, UPSC, KPSC.

Text Books

1. Durga Das Basu:"Introducing to the Constitution on India', (StudentsEdn.) Prentice – Hall EEE, 19th / 20th Edn., 2001
2. Raman B.S. and Yagi R.K., Constitutional Law and Professional Ethics, United Publishers, 2005
3. Rajaram M., Constitution of India and Professional Ethics, New Age International Publishers, 3rd Ed.,
4. Nagarazan R.S., Professional Ethics and Human Values, New Age International Publishers Pvt.Ltd. 2006

Course Outcome (COs)		
At the end of the course, the student will be able to**:**		Bloom's Level
1.	Know and explain state and central policies, fundamental duties.	L1, L2
2.	Know and explain the functioning of the democracy in the country	L1, L2
3.	Appreciate and practice the ethical issues	L3
4.	Know and apply the code of ethics practiced in the professional bodies.	L1, L3

Program Outcome of this course (POs)		**PO No.**
1.	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
2.	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Course delivery methods		**Assessment methods**	
1.	Lecture	1.	I. A. test
2.	Presentation	2.	SEE
3.	Expert talks		

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best 2 out of 3 IA tests	Average of assignments (Two) / activity	Quiz	Class participation	Total Marks
Maximum Marks: 25	25	----	----	-----	25
➢ Writing two IA tests is compulsory. ➢ Descriptive type questions. ➢ One unit each for each IA test. ➢ **Minimum marks required to qualify for SEE :** 10 marks out of 25					

Scheme of Semester End Examination (SEE):

1. SEE question paper for 50 marks having descriptive type questions will be conducted for two hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.

2. Choice in each unit.

COURSE TITLE: EMPLOYABILITY SKILLS - II

Semester	VI Semester	**Batch**	B.E/B.Tech
Course Code		**Credits**	MNC
Course Type	**HS**	**CIE Marks**	50 Marks
Hours/Week: L-T-P	3 – 0 – 0	**SEE Marks**	--
Total Hours	30 Hours	**SEE Duration**	--

Course Learning Objective

The course is designed to develop the employability skills of a student.

Syllabus

Module 1 **6 Hours**

***Quantitative Aptitude*:** Time, Speed and Distance (3)

Verbal Ability: Change of Speech and Voice (3)

Module 2 **6 Hours**

***Quantitative Aptitude*:** Permutation and Combination (2)

***Logical Reasoning*:** Coding and Decoding (1), Syllogisms (1.5)

Soft Skills: Interview Skills (1.5)

Module 3 **6 Hours**

***Quantitative Aptitude*:** Probability (2),

***Logical Reasoning*:** Data Sufficiency (1), Clocks (1.5), Calendars (1.5)

Module 4 **6 Hours**

***Quantitative Aptitude*:**Alligation and Mixtures (2), Data Interpretation (1)

***Logical Reasoning*:** Cubes (1)

Verbal Ability: Closet Test (2)

Module 5 **6 Hours**

***Quantitative Aptitude*:** Simple and Compound Interest (2), Ages (1)

Soft Skills: Resume Writing (1.5), Group Discussions – Mock (1.5)

Text Books:

1. How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.

2. How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.

3. 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.

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

Course Outcomes (Cos):

On completion of this course, students will be able to:

1. Clear the Aptitude round of recruiters during placements

2. Perform confidently during the GD and Interview process

3. Develop resumes that are grammatically correct and written in Business English

4. Develop behaviors that are appropriate for a professional

Course Delivery Methods	**Assessment Methods**
- Black Board Teaching	- Internal Assessment Test
- Power Point Presentation	- Assignments
- Class Room Exercise	- Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two Online Tests	Class Participation	Total Marks
Maximum Marks: 50	25	15	10	50

- Writing two IA tests is compulsory
- **Minimum marks required to clear the subject: Minimum IA test marks (Average) 10 out of 25 AND total CIE marks 20**