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.

7th & 8th 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.

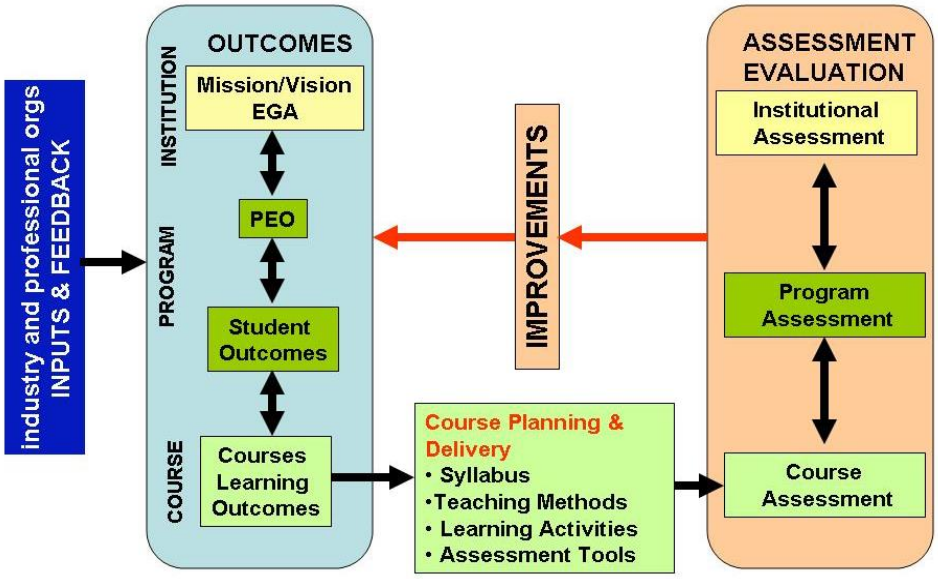
QUALITY POLICY

- 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.

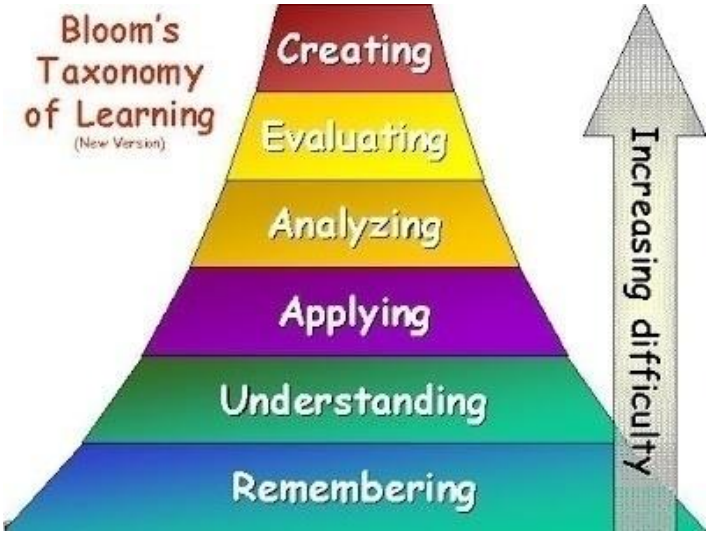
3.To demonstrate an understanding of the concepts of Electronics technology in the form of Analog and Digital Electronics, Microprocessors and embedded systems required in data acquisition, data processing, automation and control applications and demonstrate capability to comprehend the technological 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'S TAXONOMY OF LEARNING OBJECTIVES

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 byBenjaminBloomandmodifiedduringthe1990'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	Break down 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.



Scheme of Teaching and Examination- 3rd to 8th Semester B.E.

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

Seventh Semester									
S.No.	**Code**	**Course**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1	18EE71	Management & Entrepreneurship	HS	3 - 0 - 0	3	3	50	50	100
2	18EE72	High Voltage Engineering	PC	4 - 0 - 0	4	4	50	50	100
3	18EE73	Computer Applications to Power Systems	PC	3– 2 - 0	5	4	50	50	100
4	18EEPE74X	Professional Elective-IV	PE	3 – 0 - 0	3	3	50	50	100
5	18EEPE75X	Professional Elective-V	PE	3 - 0- 0	3	3	50	50	100
6	18EEOE76X	**Open Elective - III**	OE	3 – 0 - 0	3	3	50	50	100
7	18EEL77	Power system simulation, Relay & HV Lab	PC	0 – 0 - 2	2	1	25	25	50
8	18EEL78	Data Acquisition Lab	PC	0 - 0 - 2	2	1	25	25	50
9	18EE79	**Seminar on Project synopsis (Design Thinking Approach) Project Phase -1**	**PC**	0 – 0 - 2	2	1	25	--	25
		Total			**27**	**23**	**375**	**350**	**725**

Project Phase -1: CIE- 25 marks (Average of 25 marks –Internal guide and 25 marks- presentation)

List of Professional Electives –IV

S.No.	Course code	Course Title
1	18EEPE741	Power System Planning
2	18EEPE742	Computer Control of Electric Drives
3	18EEPE743	Electrical design, estimation and costing
4	18EEPE744	HVDC transmission
5	18EEPE745	Smart Grid

List of Professional Electives -V

S.No.	Course code	Course Title
1	18EEPE751	Power systems Dynamics and Stability
2	18EEPE752	Electric Power Quality
3	18EEPE753	AI applications to Power systems
4	18EEPE754	Industrial Automation using IoT
5	18EEPE755	Digital Control System

List of Open Electives -III

S.No.	Course code	Course Title
1	18EEOE761	Instrumentation& Data Acquisition
2	18EEOE762	Utilization of Electric Power
3	18EEOE763	Energy Auditing
4	18EEOE764	Energy Conservation
5	18EEOE765	Testing & Commissioning of Electrical Equipment

Eighth Semester									
S.No	**Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18EE81	Internship	PC			2	50	--	50
2.	18EE82	Intellectual Property Rights	HS	Self Study		1	50		50
3.	18EE83	Professional Certification – 1 (English / any other foreign language)	HS			1	25	--	25
4.	18EE84	Professional Certification – 2	PC			1	25	--	25
5.	18EE85	Project Phase -2	PC			2	50(25+25)	--	50
6.	18EE86	Project Phase -3	PC			4	50(25+25)	--	50
7.	18EE87	Project Phase-4 (Final Viva Voce)	PC	Final		5	--	100	100
		Total				**16**	**250**	**100**	**350**

Internship: 6 to 8 weeks duration

Project Phase -2 and 3: CIE- 50 marks (25 marks –Internal guide + 25 marks- presentation)

VII SEMESTER

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	18EE71	**Credits**	3
Course type	HS	**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 characteristics of management, role of Management, importance and purpose of planning, organizing, staffing, directing and controlling.
2. Understand meaning of entrepreneur, development of entrepreneurship.
3. Understand source of new idea, ideas into opportunities. Creative problem solving.
4. Apply the aggregate planning strategies.
5. Understand of the different schemes like TECKSOK, SIDBI, KIADB, make In India, start up India, digital India.

Unit – I 8 Hours

Management: Introduction, nature and characteristics of management, scope and functional areas of management.

Planning: Nature, importance and purpose of planning process, types of plans, decision making, and importance of planning, steps in planning.

Organizing: Nature and purpose of organization, principles of organization, types of organization, span of control, MBO.

Unit – II 8 Hours

Staffing, Directing & Controlling: Nature and importance of staffing, sources of recruitment, process of selection & recruitment, training, education and development.

Directing: Meaning and nature of directing, leadership styles, motivation theories, maslows hierarchy need of theory, theory X and theory Y, motivation and hygiene theory, communication- meaning and importance

Controlling: Meaning and steps in controlling, essentials of a sound control system, methods of establishing control.

Unit – III **8 Hours**

Entrepreneur: Meaning of entrepreneur, Characteristics of successful Entrepreneur, functions of an entrepreneur, types of entrepreneur, concept of entrepreneurship, stages in entrepreneurial process.

Creativity and Innovation: Creativity, source of new idea, ideas into opportunities, creative problem solving: heuristics, brainstorming, synectics, significance of intellectual property rights.

Unit – IV **8 Hours**

Micro, Small and Medium Enterprises [MSMEs] and Institutional Support: Business environment in India, role of MSMEs, government policies towards MSMEs, impact of liberalization, privatization and globalization on MSMEs.

Institutional support: NSIC, TECKSOK, KIADB, KSSIDC, SIDBI; KSFC

Unit – V **8 Hours**

Preparation of Project report and Business Plan: Meaning of Project, project identification, project selection, project report, need and significance of report, contents.

Business Plan: Need of business plan, anatomy of business plan, executive summary, business description, business environment analysis, background information.

Text Books

1. Henry Koontz, "Essentials of Management", Latest Edition.
2. Poornima.M.Charantimath, "Entrepreneurship Development", Pearson Education – 2014 Edition.

Reference Books

1. Donald Kurtko and Richard, "Entrepreneurship in new Millennium", South Western Carnage Learning.
2. N V R Naidu, "Management & Entrepreneurship", IK International.
3. P.C.Tripathi, P.N.Reddy "Principles of Management", TMH.
4. Dr.M.M.Munshi, Prakash Pinto and Ramesh Katri, "Entrepreneurial Development", Himalaya Publishing House.

Course Outcome (COs)

	At the end of the course, the student will be able to	Bloom's Level
1.	Explain the Functions of management, characteristics of management, importance and purpose of planning, organizing, staffing, directing and controlling.	**L1**
2.	Explain Meaning of entrepreneur, Development of Entrepreneurship and steps in developing entrepreneurship.	**L2, L3**
3.	Describe Source of New Idea, Ideas into Opportunities. Creative Problem Solving etc.	**L4**
4.	Describe the different Schemes like TECKSOK, KIADB etc. and also Make In India, Start Up India, Digital India concepts.	**L2, L3**

	Program Outcome of this course (POs)	PO No.
1.	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**
2.	Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi disciplinary settings.	**PO9**
3.	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**
4.	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.	**PO11**
	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. Videos
3. 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.

HIGH VOLTAGE ENGINEERING

Course Code	18EE72	**Credits**	4
Course type	PC	**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 to

1. Understand necessity of high voltage generation and explain the breakdown phenomenon in gases insulating medium.
2. Understand and explain the breakdown phenomenon in solid and gaseous insulating medium.
3. Explain and analyze the generation of HVAC, HVDC and impulse voltage and current. To understand and generate the lighting and switching impulses.
4. Explain &analyze the various methods to measure high voltages both Ac and DC also impulse currents.
5. Describe the non-destructive insulation testing techniques. Analyze the various tests on circuit breakers, transformer, isolators and cables.

Pre-requisites: Basic Electrical Engineering, Electrical Engineering Materials

Unit – I **10 Hours**

Introduction: Need for generating high voltages in laboratory. Classification of HV insulating media. Properties of important HV insulating media under each category.

Breakdown in gases: Gaseous dielectrics, Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory breakdown in non uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of Breakdown.

Unit – II **10 Hours**

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

Unit – III **10 Hours**

Generation of HVAC, HVDC, impulse voltage and current: HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade, series resonant circuit- principle of operation and advantages, Tesla coil, HV DC-voltage doubler circuit, cock croft- Walton type high voltage DC set, calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop. (No

derivation)
Introduction to standard lightning and switching impulse voltages, expression of single stage impulse generator- for Output impulse voltage, multistage impulse generator working of Marx impulse, rating of impulse generator, components of multistage impulse generator, triggering of impulse generator by three electrode gap arrangement, Trigatron gap, generation of switching impulse voltage, generation of high impulse current.

Unit - IV **10 Hours**

Measurement of high voltages and currents: Chubb and Fortescue method for HV AC measurement, generating voltmeter- principle &construction, series resistance micro ammeter for HV DC measurements, standard sphere gap measurements of HV AC, HV DC, and impulse voltages; factors affecting the measurements. Potential dividers-resistance dividers capacitance dividers mixed RC potential dividers, measurement of high impulse currents-Rogowski coil and magnetic links.

Unit - V **10 Hours**

Non-destructive insulation testing techniques: Dielectric loss and loss angle measurements using Schering Bridge. Need for discharge detection and PD measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods. Tests on circuit breakers and transformers.

Text Books

1. M.S.Naidu and Kamaraju, **"High Voltage Engineering"**, 4th Edition onwards, TMH.
2. E.Kuffel and W.S. Zaengl, **"High Voltage Engineering Fundamentals"**, 2nd Edition, Elsevier Press.
3. C.L.Wadhwa, **"High Voltage Engineering"**, New Age International Private limited.

Reference Books

1. Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, RoshdyRadwan, **"High Voltage Engineering Theory and Practice"**, 2ndEdn(Revised & Expanded) Marcel-Dekker Publishers(Special Indian Edn.).

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** the necessity of high voltage generation and the breakdown phenomenon in gases insulating medium.	L2
2.	**Describe** the various breakdown phenomenon in solid and gaseous insulating medium.	L2

3.	**Explain and analyze** the generation of HVAC, HVDC and impulse voltage and current.	L2, L3
4.	**Explain &analyze** the various methods to measure high voltages and high currents.	L2, L3
5.	**Describe** the non-destructive insulation testing techniques and **analyze** the various tests on circuit breakers, transformer, isolators and cables.	L2, L4

PO No.

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.	**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
3. 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.

COMPUTER APPLICATIONS TO POWER SYSTEMS

Course Code	18EE73	**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 the basic principles of matrix algebra, elementary graph theory and primitive network
2. Explain the formation of network matrices – Ybus & Zbus
3. Understand and explain the power flow equations, classification of different types of buses and different methods of load flow analysis.
4. Understand & explain the economic generation scheduling &transmission losses
5. Explain the numerical solution of swing equation by various methods with flowcharts.

Pre-requisites: Matrix algebra, power system analysis, engineering maths iterative methods

Unit - I 10 Hours

Network topology: Introduction, Elementary graph theory - oriented graph, tree, co tree, basic cut-sets, basic loops; Incidence matrices - Element-node, Bus incidence, Tree-branch path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop, Primitive network - impedance form and admittance form.

Self learning topics: Primitive network - impedance form and admittance form.

Unit - II 10 Hours

Network matrices: Introduction, formation of Y_{BUS} by method of inspection (including Transformer off-nominal tap setting) and method of singular transformation ($Y_{BUS} = A^T yA$), formation of bus impedance matrix by step by step building algorithm (without mutual coupling elements), modification of Z bus for the changes in network (problems)

Self learning topics: modification of Z bus for the changes in network

Unit - III 10 Hours

Load flow studies: Introduction, power flow equations, classification of buses, operating constraints, data for load flow, Gauss-Seidal Method - algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), acceleration of convergence; Newton Raphson's Method - Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only). Algorithm for Fast Decoupled load flow method (numerical problem for one iteration

only), comparison of load flow methods.

Self learning topics: Comparison of Load Flow Methods

Unit - IV **10 Hours**

Economic operation of power system: Introduction to Basics of Unit Commitment, performance curves, economic generation scheduling neglecting losses and generator limits, economic generation scheduling including generator limits and neglecting losses; economic dispatch including transmission losses, solution of economic dispatch with losses; derivation of transmission loss formula

Self learning topics: Basics of Unit Commitment

Unit - V **10 Hours**

Transient stability studies: Numerical solution of swing equation - point-by-point method, modified Euler's method, Runge-Kutta method, Milne's predictor corrector method. Representation of power system for transient stability studies - load representation, network performance equations. Solution techniques with flow charts.

Self learning topics: Representation of power system for transient stability studies - load representation

Text Books

1. Stag, G. W., and EI-Abiad, A. H., **"Computer Methods in Power System Analysis",** McGraw Hill, International Student Edition.
2. Pai, M. A , **"Computer Techniques in Power System Analysis",** TMH, 2nd edition.
3. K.Uma Rao, **"Computer Techniques and models in power systems",** I.K. International Publications.

Reference Books

1. Nagrath, I. J., and Kothari, D. P, **"Modern Power System Analysis",** TMH, 3rd Edition.
2. Dhar, R. N, **"Computer Aided Power System Operations and Analysis",** TMH.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain& Apply** the concept of Network Topology and primitive network, network matrices	L2,L5
2.	**Construct** Ybus by the method of inspection and singular transformation a**nd** Zbus by step by step building algorithm	L2, L3, L4
3.	**Formulate** the solution of the load flow problem using different Numerical techniques	L1, L3, L4, L5

4.	**Solve** issues of economic load dispatch and unit commitment	L2, L4, L5, L5
5.	**Apply** Point by Point method and Runge Kutta Method to solve Swing Equation	L1, L2, L3, 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 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.

POWER SYSTEM PLANNING

Course Code	18EEPE741	**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** primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution
2. **Apply** knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
3. **Understand** economic appraisal to allocate the resources efficiently and appreciate the investment decisions
4. **Understand** expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.

Pre-requisites: Basic Electrical Engineering, Electrical Power Systems

Unit – I 8 Hours

Introduction of power planning, National and regional planning, structure of power system, planning tools, electricity regulation, Load forecasting, forecasting techniques, modeling. Generation and transmission planning, Integrated power generation, co-generation / captive power, power pooling and power trading, transmission & distribution planning.

Unit – II 8 Hours

Power-System Economics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit – Risk Assessment, Optimum Investment, Tariffs. Electricity Forecasting: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System

Unit – III 8 Hours

Generation Expansion: Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies. Generation Expansion (continued): Distributed Power Generation, Renovation and Modernisation of Power Plants. Transmission Planning: Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.

Unit – IV **8 Hours**

Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand-Response Technologies, Energy Efficiency, Energy – Economical Products, Efficient – Energy Users, Supply -Side Efficiency, Energy Audit

Unit – V **8 Hours**

Electricity Market: Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market.

Text Books

1 A.S.Pabla, "Electric Power Planning", Mc Graw Hill, 2nd Edition 2016

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution	L2
2.	**Apply** knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.	L3
3.	**Explain** economic appraisal to allocate the resources efficiently and appreciate the investment decisions	L2
4.	**Explain** expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.	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 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.

COMPUTER CONTROL OF ELECTRIC DRIVES

Course Code	18EEPE742	**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 fundamental principles of various AC machines and drives.
2. Describe different types of induction motor slip-power recovery schemes.
3. Discuss various AC drive control methods.
4. Apply expert system and fuzzy logic principles for drives control.

Pre-requisites: Electric machines, power electronics, microcontrollers and fuzzy logic.

Unit - I **08 Hours**

AC machines in drives-I: Induction machines- torque production, equivalent circuit analysis, torque-speed curve, NEMA classification of machines, variable-voltage, constant-frequency operation, variable-frequency operation, constant volts/Hz operation, drive operating regions, variable stator current operation, effect of harmonics.

Self learning topics: equivalent circuit analysis

Unit - II **08 Hours**

AC machines in drives-II: Synchronous machines-Wound field machine- equivalent circuit, developed torque, salient pole machine characteristics, synchronous reluctance machine, permanent magnet machine, variable reluctance machine (VRM).

self learning topics: VRM

Unit - III **08 Hours**

Induction motor slip-power recovery drives: Introduction, doubly-fed machine speed control by rotor rheostat, static Kramer drive, static Scherbius drive.

self learning topics: speed control by rotor rheostat

Unit - IV **08 Hours**

Control of induction motor drives: introduction, vector of field-oriented control, indirect or feed forward vector control, vector control of line-side PWM rectifier, stator flux-oriented vector control, direct torque and flux control (DTC).

Expert system principles and applications: Introduction, expert system principles, expert system shell, design methodology, applications.
Self learning topics: expert system principles

Unit - V **08 Hours**

Fuzzy logic principles and applications: Introduction, fuzzy sets, fuzzy system, defuzzification methods, fuzzy control, general design methodology, applications.

self learning topics: fuzzy sets

Text Books

1. Bimal K. Bose, "**Modern Power Electronics & Drives**", PHI, 2011.
2. Bimal K. Bose, "**Power Electronics and Motor Drives**", Elsevier, 2010.
3. BadriRam , **"Fundamentals of Microprocessors and applications"**, Pearson, 2001.

Reference Books

1. Pleera A Thollot IEEE Technology Update Series-"**Power Electronics Technology andApplications**",1993.
2. B.K.Bose "**Power Electronics and Variable Frequency Drives Technology andApplications"**, IEEE presses,1997.

E-Resources: https://nptel.ac.in/courses/108/104/108104011/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain fundamental principles of various AC machines and drives.	L2
2. Describe different types of induction motor slip-power recovery schemes.	L3
3. Analyze various AC drive control methods.	L4
4. Apply expert system and fuzzy logic principles for drives control.	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 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):

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 DESIGN, ESTIMATION AND COSTING

Course Code	18EEPE743	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 basic concepts in estimation and costing, Indian Electricity Act and major applicable I.E rules
2. Explain general guidelines for wiring and estimation of residential and commercial installation.
3. Demonstrate an understanding of design estimation of overhead transmission & distribution lines.

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

Unit – I 08 hours

General principles of estimation: Introduction to estimation & costing, electrical schedule, catalogues, market survey and source selection, recording of estimates, determination of required quantity of material, labour conditions, determination of cost material and labour, contingencies, overhead charges, profit, purchase system, purchase enquiry and selection of appropriate purchase mode, comparative statement, purchase orders, payment of bills, tender form, general idea about IE rule, Indian electricity act and major applicable I.E rules.

Unit – II 08 Hours

Residential building electrification: General rules guidelines for wiring of residential installation and positioning of equipments, principles of circuit design in lighting and power circuits, procedures for designing the circuits and deciding the number of circuits, method of drawing single line diagram, selection of type of wiring and rating of wires and cables, load calculations and selection of size of conductor, selection of rating of main switch, distribution board, protective switchgear ELCB and MCB and wiring accessories, earthing of residential installation, sequence to be followed for preparing estimate, preparation of detailed estimates and costing of residential installation.

Unit – III 08 hours

Electrification of commercial installation: Concept of commercial installation, differentiate between electrification of residential and commercial installation, fundamental considerations for planning of an electrical installation system for commercial building, design considerations of electrical installation system for commercial building, load calculation and selection of size

of service connection and nature of supply, deciding the size of the cables, bus bar and bus bar chambers, mounting arrangements and positioning of switchboards, distribution boards main switch etc, earthing of the electrical installation, selection of type wire, wiring system and layout, sequence to be followed to prepare estimate, preparation of detailed estimate and costing of commercial installation.

Unit – IV **08 Hours**

Electrical installation for power circuits: Introduction, important considerations regarding motor installation wiring, determination of input power, determination of input current to motors, determination of rating of cables, determination of rating of fuse, determination of size of conduit, distribution board main switch and starter.

Unit – V **08 hours**

Design and estimation of overhead transmission & distribution lines: Introduction, typical ac electrical power system, main components of overhead lines, line supports, factors governing height of pole, conductor materials, determination of size of conductor for overhead transmission line, cross arms, pole brackets and clamps, guys and stays, conductors configuration spacing and clearances, span lengths, overhead line insulators, insulator materials, types of insulators, lightning arrestors.

Text Books

1. J.B.Gupta, **"Electrical Installation Estimating & Costing"** VIII Edition S.K. Katria& Sons New Delhi
2. K.B.RainaS.K.Bhattacharya, **"Electrical Design Estimating and Costing"**, New Age International publications.
3. Dr.S.L.Uppal**, "Electrical Wiring Estimating and Costing"**, Khanna Publishers, Delhi.

Course Outcome (COs)

At the end of the course, the student will be able to	**Bloom's Level**
1. **Formulate** 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	L2
2. **Explain and apply** the general rules guidelines for wiring of residential installation and commercial installation.	L2
3. **Describe** the concept of service connection, types of service connection and their features	L4
4. **Explain** and **design** the overhead transmission & distribution lines	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. **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.	PO11
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.

HVDC TRANSMISSION

Course Code	18EEPE744	**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. Understand and compare the DC verses AC transmission
2. Explain and understand the Main Design Consideration of thyristor converters system.
3. understand, explain and analyze Control of HVDC converters Systems, Convertor Control and DC System Control
4. Understand; explain the basic components of harmonics and elimination techniques using filters.
5. Understand the Fault Development and Protection on AC and DC line.

Pre-requisites: Power Electronics

Unit – I 8 Hours

DC verses AC transmission. Power carrying capacity of AC and DC lines, Comparison of AC and DC transmission characteristics, other considerations, Infeeds at lower voltages, Break even distances, and environmental considerations, Existing AC transmission facilities converted for use with DC, Very long distance transmission.

Unit – II 8 Hours

Main Design Considerations. Introduction, Thyristor valve, Station layout, Relative cost of convertor components, convertor transformer, smoothing reactor, Overhead lines, Cable Transmission, Earth electrodes, Design of back to back thyristor convertor systems, HVDC system upgrade.

Unit - III 8 Hours

Control of HVDC converters and Systems.

A) Convertor Control. Basic philosophy, Individual phase control, equidistance firing control, and 12 pulse convertor analysis (No derivations).

B) DC System Control. Basic philosophy, Characteristics and direction of DC power flow, Different control levels, and Telecommunication requirements.

Unit - IV **8 Hours**

Harmonic Elimination. Introduction, Pulse number increase, Active filters, Reactive power control.

Unit - V **8 Hours**

Protection and Reactive Power Control. Introduction, Converter disturbances, ACX system faults, DC line fault development, Over current protection. New concepts in HVDC converters and systems. Advance devices, new concept for thyristor convertors, compact convertor station, GTO based voltage source inverter.

Self learning topics: GTO based voltage source inverter.

Text Books

1. **"High Voltage Direct Current Transmission"** by Jos Arrillaga, 2nd edition, Power and energy series 29 IET.
2. **"HVDC Power Transmission Systems"** by K R Padiyar, New age international publications, First edition.

Reference Books

1. **Direct Current Transmission,** EW Kimbark.
2. **"HVC Transmission"** by S Kamakshaiah and V kamaraju. Tata McGraw Hill Edu Pvt Ltd

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand and compare the DC verses AC transmission there advantage and disadvantages.	L1, L2, L3
2.	Explain and understand the Main Design Consideration of thyristor converters system, station layout, mercury valve.	L2,L3, L4
3.	Understand, explain and analyze Control of HVDC converters Systems, Convertor Control and DC System Control	L1, L3, L4
4.	Understand and explain the basic components of harmonics and elimination techniques using filters. Also analyse the reactive power control	L2, L3, L4
5.	Understand and explain the Fault Development and Protection on AC and DC line. Also the operation of various type of converters and differentiate between them.	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	2

complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

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. 12

Course delivery methods

1. Chalk Board
2. Power Point Presentations
3. 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.

SMART GRID

Course Code	18EEPE745	**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 need for smart grid and challenges in implementation of smart grid.
2. Understand and explain the Substation Automation, Feeder Automation
3. Identify and describe the issues of grid integrated renewable energy sources.
4. Describe the concepts of smart metering and PMU.
5 Demonstrate an understanding of Power Quality issues of Grid connected Renewable Energy Sources.

Pre-requisites: Power system analysis, Renewable energy sources.

Unit - I 8 Hours

Evolution of electric grid, concept, definitions and need for smart grid, smart grid drivers, functions, opportunities, challenges and benefits, difference between conventional & smart grid, present development & international policies in smart grid.

Self learning topics: Definitions and need for smart grid

Unit - II 8 Hours

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

Self learning topics:, Substation Automation, Feeder Automation

Unit - III 8 Hours

Introduction renewable energy generation photovoltaic systems, wind, hydro and tidal energy systems, fault current limiting, shunt compensation D-STATCOM active filtering shunt compensator with energy storage and series compensation.

Self learning topics: Introduction renewable energy generation photovoltaic systems, wind, hydro and tidal energy systems

Unit - IV 8 Hours

Introduction to smart meters advanced metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor measurement unit (PMU), intelligent electronic devices (IED) & their application for monitoring &

protection.
Self learning topics: Smart Meters.

Unit - V **8 Hours**

Electromagnetic Interference: Introduction, frequency classification, electrical fields, magnetic fields, electromagnetic interference terminology, power frequency fields, high-frequency interference, electromagnetic interference susceptibility, EMI mitigation, cable shielding to minimize electromagnetic interference, health concerns of electromagnetic interference.
Self learning topics: EMI mitigation, cable shielding to minimize electromagnetic interference, health concerns of electromagnetic interference.

Text Books

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke, **"Smart Grid Technologies: Communication Technologies and Standards",** IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang **"Smart Grid – The New and Improved Power Grid: A Survey",** IEEE communication survey and tutorials, vol-14, issue 4, 2012.
3. C. Sankaran, **"Power Quality"**, CRC Press LLC, 2002.

Reference Books

1. Stuart Borlase**"Smart Grid: Infrastructure, Technology and Solutions",** CRC Press.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, **"Smart Grid: Technology and Applications",** Wiley publications.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Explain** the importance, challenges and benefits of smart grid.	L2
2. **Describe** the substation Automation and Feeder Automation.	L2, L3
3. **Explain** and **apply** renewable energy sources integration with smart grid.	L2, L3
4. **Describe** the Smart Meters, Advanced Metering in smart grid.	L2, L3
5. **Explain** and **apply** Power Quality issues of Grid connected Renewable Energy Sources	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	PO5

limitations.

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	Assessment methods
1. Black board teaching	1. Internal Assessments and Quiz
2. Power Point presentation	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 SYSTEMS DYNAMICS AND STABILITY

Course Code	18EEPE751	**Credits**	03
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 concept of classical methods with modelling of synchronous machine.
2. Demonstrate an understanding of formulation, construction and explanation of Symmetrical short circuit analysis of generator. Solution for transient analysis
3. Analyze the performance AVR in terms of time domain specifications.
4. Understand and explain the concept modelling for prime movers.
5. Explain the concept of load modelling and stability analysis

Pre-requisites: Generation, Transmission and Distribution system components

Unit – I 08 Hours

Introduction : Basic concepts, Review of classical methods. Modeling of synchronous machine, Swing equation, Park's transformation – Park's voltage equation, Park's mechanical equation (torque).

Unit – II 08 Hours

Applications – (a) Voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator. Solution for transient analysis, Operational impedance, Relationship between T'do and T"do, Algebraic constraints.

Unit – III 08 Hours

Excitation And Prime Mover Controllers:

Introduction, Types of excitation, AVR with and without ESS, TGR, Amplifier PSS, Static exciters.

Unit – IV 08 Hours

Modelling Prime Movers:

Introduction, Three major components, Block diagram, Hydraulic turbine, Steam turbine.

Unit – V **08 Hours**

Load Modeling And Stability

Introduction, Two approaches – Polynomial model and Exponential model. Small Signal Angle Stability: Small signal angle stability with SMIB system, detailed model of SMIB. Simulation for Transient stability Evaluation

Text Books

1. K. R. Padiyar, *Power System Dynamics, Stability And Control*, Interline Publishing (P) Ltd., Bangalore, 1999.
2. I. J. Nagrath and D. P. Kothari, *Power System Engineering*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1994.
3. P. Kundur, *Power System Stability and Control*, McGraw Hill, New York, 1994.

Reference Books

1. O. I. Elgerd, *Electric Energy System Theory: An Introduction*, 2nd ed., McGraw Hill, New York, 1982.
2. A. J. Wood and B. F. Wollenberg, *Power Generation, Operation And Control*, 2nd ed., John Wiley And Sons, New York, 1996.
3. . J. Arrillaga, C. P. Arnold and B. J. Harker, *Computer Modeling Of Electrical Power Systems*, Wiley, New York, 1983.

E-Resources: NPTEL Courses run by IIT Mumbai.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** the concept and **classification** of control systems.	L2
2.	**Formulate**, **construct** and **explain** models of physical systems in terms of differential equations, transfer functions, block diagrams, signal flow graph.	L3, L4
3.	**Explain** and **analyze** performance of feedback control systems in terms of Time domain specifications.	L2, L4
4.	**Explain** the concept of absolute and relative Stability of feedback control systems using R-H criterion, Root locus technique, frequency domain **analysis** methods such as polar plots and Bodes plots	L2, L4
5.	**Explain** the concept of compensation in feedback control systems, types of compensators, functions of PID controllers 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.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using	PO2

first principles of mathematics, natural sciences and engineering sciences.

3. **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 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 and Board
2. Presentations
3. Simulations

Assessment methods

1. Open Book Assignments
2. Quizzes
3. Internal Assessment Tests
4. Course Seminar / Project (Mini project)
5. Case Studies

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 POWER QUALITY

Course Code	18EEPE752	Credits	03
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** power quality issues.
2. **Understand** harmonics and their sources
3. **Understand** the methods to Suppress harmonics through active and passive filters.
4. **Understand** the methods of Mitigating voltage sags and interruptions.
5. **Understand** harmonic measurement and power quality monitoring techniques.

Pre-requisites: Basic Electrical Engineering, Power systems, Power Electronics

Unit – I **8 Hours**

Introduction, Power quality-voltage quality, power quality evaluation procedures term and definitions: general classes of power quality problems, transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms

Unit – II **8 Hours**

Voltage sags and interruptions: Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags. Transient over voltages: Sources of transient over voltages, principles of over voltages protection, utility capacitor switching transients

Unit – III **8 Hours**

Fundamentals of harmonics: Harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intraharmonics. **Harmonic distortion evaluations**, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics

Unit – IV **8 Hours**

Power Quality monitoring considerations, power quality measurement equipments, assessment of power quality measurement data, application of intelligent systems, power quality monitoring standards.

Unit – V **Hours**

Harmonic suppression filters: Shunt passive filters, design considerations case studies, voltage/ current source active filters- types: shunt, series and hybrid types, comparison.

Text Books

1. Electric Power Quality, Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/ Beaty, H. Wayne, McGraw-Hill professional publication 2003.
2. **Understand** and **Explain** harmonics and their sources
3.

Reference Books

1. Electric Power Quality, G.T.Heydt, stars in a circle publications 1991
2. Power quality in power systems and electrical machines, Ewald F Fuchs, Mohammad A.S., Masoum, Academic Press, Elsevier, 2009.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** power quality issues.	L2
2.	**Explain** harmonics and their sources	L2
3.	**Explain** the methods to Suppress harmonics through active and passive filters.	L2
4.	**Explain the** methods of Mitigating voltage sags and interruptions.	L2
5.	**Explain** harmonic measurement and power quality monitoring techniques.	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. **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.

AI APPLICATIONS TO POWER SYSTEMS

Course Code	18EEPE753	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	100
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course learning objectives

To impart an ability to the students to

1. **Understand** the necessity of applying AI techniques in power systems
2. **Understand** the overall view of different AI techniques and their utility
3. **Understand** the operation of different AI techniques such as ANN, Fuzzy Logic, Genetic Algorithm
4. **Understand** AI techniques in Electrical power systems

Pre-requisites: Power systems and analysis, Numerical Techniques

Unit - I 6 Hours

Introduction, Overall view of power systems, Introduction to Artificial Intelligence AI, Necessity of AI in Power systems, Introduction to AI techniques ANN, Fuzzy logic, Genetic algorithms, Expert systems and their advantages and disadvantages and applications, Comparison of different AI techniques

Unit – II 8 Hours

Artificial Neural Networks:

Fundamentals Of Neural Networks: Basic Concept, Neural Network Architectures, Characteristics, Learning Methods, early NN Architectures, Back propagation Networks: Architecture, Learning, Illustration of ANN operations

Unit – III 8 Hours

Fuzzy Logic:

Fuzzy Set theory, Crisp Set, Fuzzy set, Crisp relation, fuzzy relations. Fuzzy Systems: Crisp, predicate and fuzzy logic, Rule based system, Defuzzification methods, Illustration of Fuzzy logic.

Unit – IV **8 Hours**

Genetic Algorithms:

Fundamentals, History, basics, working principal, encoding, fitness function, reproduction, Genetic Modeling, cross over, inversion, deletion, mutation, Bit wise operator, Application. 1. Roulette wheel selection 2. Stochastic remainder Roulette wheel selection , Rank selection, Tournament selection and stochastic universal sampling, different types of cross over methods in GA.

Unit – V **8 Hours**

Applications of AI techniques in power systems, Transmission line performance improvement, Power transformer protection, Fault diagnosis, ANN, Fuzzy logic and GA in power systems operation and control for solving problems of load forecasting, voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment. Condition monitoring

Text Books

1. Kevin Warwick, Arthur Ekwue, Raj Agrawal "*Artificial intelligence techniques in power systems*".

Reference Books

1. S. Rajasekaran "*Neural Networks, Fuzzy Logic, and Genetic Algorithms Synthesis and Applications*", PHI Publication.

E-Resources: Swayam, Electric India Magazines, IEEE transactions

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Identify** and **Explain** the necessity of applying AI techniques in power systems	L2
2. **Explain** the overall view of different AI techniques and their utility	L2
3. **Explain** the operation of different AI techniques such as ANN, Fuzzy Logic, Genetic Algorithm	L2
4. **Identify** and **Apply** AI techniques in Electrical power systems	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. Board work
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.

INDUSTRIAL AUTOMATION USING IoT

Course Code	18EEPE754	**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 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 an understanding of LaRAIoT platform.

Pre-requisites: Basics of sensors, Automation

Unit - I **8 Hours**

Introduction to IoT: What is 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: What Is LoRa?, Amplitude Modulation, Frequency Modulation, Frequency Shift Keying, Chirp Spread Spectrum, LoRa Spread Spectrum Modulation, LoRa Applications, Network Coverage, Low-Power Wide Area Networks, What Is 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 LaRAIoT platform.	L2, 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. **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.

DIGITAL CONTROL SYSTEM

Course Code	18EEPE755	**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. Define State model and classify and construct state models for LTI systems and demonstrate their applications with different components of discrete control system.
2. Demonstrate an understanding of analysis of systems using state models in terms time and frequency domain analysis.
3. Demonstrate an understanding of controller design and their realization.
4. Compute state transition matrix using Cayley-Hamilton theorem and z-transform method to Assess the response between sampling instants.
5. Assess the controllability and observability of a system and design controller and observer for a given system.

Pre-requisites: Control Systems, MCT

Unit - I 08 Hours

Fundamentals and Modelling: Basic digital control system-Examples -D/A and A/D conversion, quantization and delay effects, principles of discretization, mathematical model, Data reconstruction-ZOH and FOH-choice of sampling rate--Mapping between s-domain and z-domain-Pulse transfer function-Different configurations for the design-Modified z-transform-Multi-rate discrete data systems. Sampled signal flow graph

Unit - II 08 Hours

Time and Frequency domain Analysis: Time responses of discrete data systems-Correlation between time response and root locations in the z-plane -Steady state performance-Disturbance Rejection-Robustness and Sensitivity -Jury‘s stability test –Routh stability criterion on the r-plane -Root locus-Polar plots-Nyquist stability criterion-Bode plot-Bilinear transformation method

Unit - III 08 Hours

Controller Design and Realization: Cascade compensators using Root Locus-Design of PID controllers by using bilinear transformation-Digital controller design using bilinear transformation-Dead-beat response design-Deadbeat controller without and with prescribed manipulated variable-Choice of sample time for deadbeat controller-Realization of Digital controllers-Computer based simulation.

Unit - IV **08 Hours**

State-Space Analysis: State variable model of discrete data systems with S/H devices-State transition equations-state diagrams-Transfer function-Transformation to Jordan canonical form and phase variable form-Computation of state transition matrix using Cayley-Hamilton theorem and z-transform method-Response between sampling instants.

Unit - V **08Hours**

Pole placement: Controllability, Observability, stabilizability and reachability-Loss of controllability and observability due to sampling-Pole placement design using state feedback for SISO systems-Computer based simulation.

Text Books

1. M.Gopal, Digital control and State Variable methods, Tata McGraw –Hill , 1997
2. B.C.Kuo, Digital Control Systems, 2nded., Oxford University Press,1992

Reference Books

1. R.Isermann, Digital control systems, Volume 1: Fundamentals, Deterministic control, Springer Verlag, 2ndrevised ed., and 1989.
2. Constantine H. Houpis and Gary B. Lamont, Digital control systems: Theory, hardware, software, Mcgraw-Hill Book Company, 1985.
3. G.F.Franklin, J.David Powell and M.Workman, Digital Control of Dynamic Systems,3rded., Addison Wesley, 2000
4. Phillips and Nagle, Digital control system analysis and design, Prentice Hall, 1984
5. R.G.Jacquot, Modern digital control systems, 2nded., Marcel Dekker, Inc., 1995.

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* Basic digital control system-Examples with modeling D/A and A/D conversion and mapping between s-domain and z-domain to reconstruct the signal.	L2, L3
2. *Apply* the techniques used to test the stability and time response of the discrete time systems.	L3, L2
3. *Explain* the controller design and *illustrate* the Dead-beat response design-Deadbeat controller. Realize Digital controllers and Computer based simulation	L3, L4

4.	*Explain* State transition matrix and. Apply the different methods to find the system response by constructing state transition matrix using Cayley-Hamilton theorem and z-transform method.	L2, L6
5.	*Explain* concepts of controllability, observability, stabilizability and Reachability with illustrations. *Design* of controller with computer simulations.	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

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.

Instrumentation and Data Acquisition

Course Code	18EEOE761	**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 and explain concept and components of Electric and Electronic Instrumentation
2. Understand and explain transducers, concept and types
3. Understand and explain concept of Signal conditioning and different processes
4. Understand and explain concept of Data acquisition, methods and applications
5. Understand and explain typical applications of transducers for measurement of non electric quantities

Pre-requisites: Basic Electrical and Electronics Engineering, Physics

Unit - I 8 Hours

Electric Transducers: Advantages of Electrical transducers, Classification of transducers, Primary and secondary transducers, Passive and Active transducers, Analog and Digital transducers, Transducers and Inverse transducers, types of transducers and applications, Factors influencing the choice of transducers.

Resistive transducers: Potentiometers principle of working, advantages and disadvantages, and applications. Strain gauges principle of working, types and applications, Resistance thermometers principle of working, thermistors. Thermocouples, principle of working, advantages and disadvantages.

Inductance transducers: working principle, LVDT, working and applications, advantages and disadvantages. Synchros working principle and applications.

Capacitive transducers: working principle, applications, advantages and disadvantages

Unit - II 8 Hours

Signal Conditioning: Current to voltage and voltage to current conversion, buffering methods, Amplitude modulation and Demodulation, Amplification and Attenuation.

Unit - III 8 Hours

Signal Conditioning: Filtering, Passive filters, types, Active filters, types, A/D techniques, Successive approximation ADC, voltage to time ADC, voltage to frequency ADC, D/A conversion techniques, Binary weighted resistance DAC.

Unit - IV **8 Hours**

Data Acquisition Systems(DAS): Types of Instrumentation systems, components of Analog ,Types of Multiplexing systems, Electronic TDM,FDM, components of Digital Data Acquisition System, block diagram of Modern Digital DAS and brief explanation of each component block

Unit - V **8 Hours**

Measurement of Non electric quantities: Measurement of Linear displacement using Strain gauge bridge circuit(with IC OPAMP),Measurement of Pressure using Bellow-LVDT, Measurement of Torque using inductive transducer, Measurement of Linear velocity using Moving Magnet type transducer, Measurement of Speed-AC Tachometer, Photoelectric Tachometer

Text Books

1. A course in Electrical and Electronic measurements and Instrumentation by A.K.Sawhney, Dhanpat Rai and Co, New Delhi, 2007 Edition

Reference Books

1. Electronic Instrumentation by H.S. Kalsi, Tata McGraw Hill, Second Edition

E-Resources: swayam.org

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain the concept and components of Electric and Electronic Instrumentation and apply the concept.	L2,L3
2. Explain transducers, concept and types	L2
3. Explain the concept of Signal conditioning and different processes and apply the concept.	L2,L3
4. Explain the concept of Data acquisition, methods and applications and apply data acquisition concepts and methods	L2,L3
5. Explain typical applications of transducers for measurement of non electric quantities	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.	**Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and	PO5

modeling to complex engineering activities with an understanding of the limitations.

4. **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. PO11
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 and Board
2. 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.

UTILIZATION OF ELECTRIC POWER

Course Code	18EEOE762	**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,

1. Demonstrate an understanding of different types of electric heating and electric welding
2. demonstrate an understanding of Laws of illumination, Design of lighting schemes, different types of lamps and comparison
3. Demonstrate an understanding concept of refrigeration cycle and systems.
4. Demonstrate an understanding concept of electrolytic process.
5. Demonstrate an understanding concept of electric traction.
6. Demonstrate an understanding concept of electric and hybrid vehicles.

Pre-requisites : Basic Electrical Engineering, Electrical Machines

Unit - I

a. Electric Heating: Advantages and methods of electric of heating, resistance ovens, induction heating, dielectric heating, the arc furnace, heating of building.

4 Hours

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

4 Hours

Self learning topics: Electric Welding

Unit - II

Electrolytic Process: Fundamental principles, extraction, refining of metals, electroplating. Factors affecting electro deposition process, power supply for electrolytic process.

4 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.

4 Hours

Unit - III

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

4 Hours

b. Lighting: factory lighting, flood lighting, street lighting, different types of lamps-

incandescent, fluorescent, vapor, CFL and LED lamps and their working and comparison of different types of lamps

4 Hours

Unit - IV

Electric Traction: Introduction, requirements of ideal traction System of traction, speed time curve, tractive effort at /co-efficient of adhesions, selection of traction motors

4 Hours

Method of speed control, energy saving by series parallel control, ac traction equipment. A.C. series motor, characteristics, regenerative braking, linear induction motor and their use.

4 Hours

Unit - V

AC traction, diesel electric equipment, train lighting system, specific energy, factors affecting specific energy consumption.

4 Hours

Introduction Electric And Hybrid Vehicles: Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption

4 Hours

Self learning topics: transmission requirement, vehicle performance and energy consumption

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. **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles"** - Mehrdad, Ehsani, YiminGao, Sabastien. E. Gay, Ali Emadi- CRC Press.

Reference Books

1. **"A Course in Electrical Power"** Soni Gupta and Bhatnager-DhanapatRai & sons
2. **"Electrical Power"** by Dr.S.L.Uppal Khanna Publications

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 concept of electrolytic process	L1,L2
5	**Explain** the concept of electric traction	L2,L3
6	**Explain** the concept of electric and hybrid vehicles	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	Assessment methods
1. Black board teaching	1. Internal Assessments and Quiz
2. PPT	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.

ENERGY AUDITING

Course Code	18EEOE763	**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 in the students to

1. Illustrate and understanding of the energy consumption, conservation, codes, standards and legislation.
2. Explain an understanding the time value of money concept, developing cash flow models, payback analysis, and depreciation, taxes and tax credit.
3. Summarize an understanding of elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results.
4. Explain an understanding of electrical system optimization.
5. Outline an understanding of power factor correction & location of capacitors, electrical tariff, and concept of ABT.
6. Illustrate understanding of different concepts of demand side management.

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

Unit – I 8 Hours

Introduction: Energy situation – World and India, energy consumption, conservation, codes, standards and legislation.

Unit – II 8 Hours

Energy Auditing: Introduction, Principles of Energy management, elements of energy audits, ten steps methodology for detailed energy audit, functions of energy audit team, energy use profiles, measurements in energy audits, presentation of energy audit results.

Unit – III 8 Hours

Energy Economic Analysis: The time value of money concept, types of interest, developing cash flow models, payback analysis, Economic decision making process, depreciation, taxes and tax credit – numerical problems.

Unit – IV 8 Hours

Electrical Equipment and Power Factor: Power factor, calculation of power factor correction, Energy efficient motors, lighting basics, electrical tariff, concept of ABT.

Unit – V **8 Hours**

Demand Side Management: Different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning, load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Management and organization of energy conservation awareness programs.

Text Books

1. Arry C. White, Philip S. Schmidt, David R. Brown, **"Industrial Energy Management Systems",** Hemisphere Publishing Corporation, New York.
2. Albert Thumann, **"Fundamentals of Energy Engineering",** Prentice Hall Inc, Englewood Cliffs, New Jersey.
3. A S. Pabla, "Electrical Power distribution", TMH, 5th edition.

Reference Books

1. D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, **"Recent Advances in Control and Management of Energy Systems",** Interline Publisher, Bangalore.
2. Ashok V. Desai, **"Energy Demand – Analysis, Management and Conservation",** Wiley Eastern.
3. Jyothi Prakash, **"Demand Side Management",** TMH Publishers.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Illustrate** the concept of energy consumption, conservation, codes, standards and legislation.	L2
2. **Explain** the concept of the time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit.	L4
3. **Summarize** the different parameters involving in energy auditing	L2
4. **Explain and Analyze** power factor correction, location of capacitors and electrical tariff for different kinds of loads	L4
5. **Explain** different techniques of DSM, management and organization of energy conservation awareness programs.	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. **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. Blackboard teaching	1. Internal Assessments and Quiz
2. Through PPT presentations	2. Open Book Assignment
3. Simulation software's	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.

ENERGY CONSERVATION

Course Code	18EEOE764	**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 in the students to

1. Illustrate and understanding of the energy consumption, conservation, codes, standards and legislation.
2. Explain an understanding the time value of money concept, developing cash flow models, payback analysis, and depreciation, taxes and tax credit.
3. Summarize an understanding of elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results.
4. Explain an understanding of effective energy management.
5. Illustrate understanding of different concepts of Electric Energy management.
6. Outline an understanding of power factor correction & location of capacitors, electrical tariff, and concept of ABT.

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

Unit – I 8 Hours

Introduction: Background, the value of Energy management, The energy management profession, Principles of energy management.

Unit – II 8 Hours

Energy Auditing: Introduction, Principles of Energy management, elements of energy audits, ten steps methodology for detailed energy audit, functions of energy audit team, energy use profiles, measurements in energy audits, presentation of energy audit results.

Unit – III 8 Hours

Effective Energy Management: Introduction, Energy management program, organizational Structure, energy Policy, Planning, Audit Planning, Educational Planning, Strategic Planning, Reporting, Ownership.

Unit – IV 8 Hours

Electric Energy Management: Introduction, power Supply, Effects of Unbalanced Voltages on the Performance of Motors, effect of Performance-General, Motor, Power Factor, Handy Electrical Formulas & Rules of Thumb, Electric motor Operating Loads, Determining Electric

Motor Operating Loads, Power Meter, Slip Measurement, Amperage Readings, electric Motor Efficiency, Comparing Motors, Sensitivity of Load to Motor RPM, Theoretical Power Consumption, Motor Efficiency Management.

Unit – V **8 Hours**

Electrical Equipment and Power Factor: Power factor, calculation of power factor correction, Energy efficient motors, lighting basics, electrical tariff, concept of ABT.

Text Books

1. Arry C. White, Philip S. Schmidt, David R. Brown, **"Industrial Energy Management Systems",** Hemisphere Publishing Corporation, New York.
2. Wayne C. Turner, Steve Doty, "Energy Management Handbook"6th Edition CRC Press.
3. Albert Thumann, **"Fundamentals of Energy Engineering",** Prentice Hall Inc, Englewood Cliffs, New Jersey.
4. A S. Pabla, "Electrical Power distribution", TMH, 5th edition.

Reference Books

1. D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, **"Recent Advances in Control and Management of Energy Systems",** Interline Publisher, Bangalore.
2. Ashok V. Desai, **"Energy Demand – Analysis, Management and Conservation",** Wiley Eastern.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Illustrate** the concept of energy consumption, conservation, codes, standards and legislation.	L2
2. **Explain** the concept of the time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit.	L4
3. **Summarize** the different parameters involving in energy auditing	L2
4. **Explain** different techniques and steps involved in Electric Energy Management.	L2
5. **Explain and Analyze** power factor correction, location of capacitors and electrical tariff for different kinds of loads	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. Blackboard teaching	1. Internal Assessments and Quiz
2. Through PPT presentations	2. Open Book Assignment
3. Simulation software's	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.

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS

Course Code	18EEOE765	Credits	3
Course type	OE	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, 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: NPTEL, 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 equipment's	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

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 SYSTEM SIMULATION, RELAY AND HIGH VOLTAGE LAB

Course Code	18EEL77	**Credits**	1
Course type	PC	**CIE Marks**	25
Hours/week: L-T-P	0-0-2	**SEE Marks**	25
Total Hours:	24	**SEE Duration**	3 hours for 50 marks

Course learning objectives:

To impart an ability to the students to

1. Explain & Develop source codes in MATLAB for simulating various power system problems.
2. Explain & make use of power system simulation software package
3. Illustrate an understanding of operating characteristics of microprocessor based (numeric) over –current relay and realize IDMT characteristics of over voltage or under voltage relay.
4. Illustrate measurement of HVAC and HVDC using standard gaps.

List of Experiments

1. Y-bus formation by inspection method and singular transformation method using MATLAB.
2. Load flow analysis for a 4-bus system using Newton Raphson method/Gauss-Siedel method using MATLAB and PSS package.
3. Optimal generator scheduling for thermal power plants using MATLAB/PSS package
4. Short circuit analysis for power system using MATLAB/PSS package
5. Measurement of HVAC and HVDC using standard spheres.
6. IDMT characteristics of over voltage and under voltage relay.
7. Operating characteristics of microprocessor based (numeric) over –current and definite time relay
8. Backup protection of over current relay by relay coordination.

Reference Books

1. Stag, G. W., and EI-Abiad, “Computer Methods in Power System Analysis”, A. H. - McGraw Hill, International Student Edition.
2. Nagrath. I. J., and Kothari. D. P, “Modern Power System Analysis”, TMH,3rd Edition.
3. M.S.Naidu and Kamaraju , “High Voltage Engineering”, - 4th Editions, THM.
4. C.L.Wadhwa, “High Voltage Engineering”, New Age International Private limited.

Course Outcome (COs):

At the end of the course, students will be able to	Bloom's Level
1. Compute admittance matrix by inspection method and singular transformation and verify the results using MATLAB	L3, L4
2. Analyze load flows using Gauss siedal and Newton Raphson also analyze economic operation of power plants and short circuits in a power system.	L3, L4
3. Illustrate an understanding of Operating characteristics of various relay.	L2,L3
Illustrate measurement of HVAC and HVDC using standard gaps.	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
5. **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 understanding of the limitations.	PO5
6. **Communication:** Communicate effectively with diverse audiences and be able to prepare effective reports and design documentation.	PO10
7. **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		

DATA ACQUISITION LAB

Course Code	18EEL78	**Credits**	2
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

To impart ability in students to

1. Demonstrate an understanding of IoT platform
2. Demonstrate an understanding of sensors operation.
3. Demonstrate an understanding of actuators operation.
4. Demonstrate an understanding of network server and cloud data analysis.

Pre-requisites :Basic Electrical and Electronics, Power Electronics

List of experiments

1. Configuring LoRa LG-01 gateway with TTN, creating application and registering device in ABP mode.
2. String data transfer in ABP mode using LoRaIoT module.
3. Real-time monitoring and measurement of weather data in ABP mode using LoRaIoT module
4. Water level monitoring using LoRaIoT module and analyze data in cloud.
5. Relay based real-time control of electrical equipments.
6. Monitor the ambient light using LoRaIoT platform and transmitting data to cloud.
7. Real-time monitoring and detection of flame in ABP mode using LoRaIoT module.
8. Real-time measurement of the inflow of current through the conductor in ABP mode using LoRaIoT module.
9. Lamp status control using node MCU.

Books

1. **The Internet of Things: Key Applications and Protocols, 2nd Edition**, Olivier Hersent, David Boswarthick, Omar Elloumi, Wiley publication, Feb 2012
2. **Signals & Systems,** D Ganesh Rao Satish Tunga, Published by Pearson Education Limited

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Demonstrate** an understanding of IoT platform	L4
2. **Demonstrate** an understanding of sensors operation.	L3
3. **Demonstrate** an understanding of actuators operation.	L5
4. **Demonstrate** an understanding of network server and cloud data analysis.	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
5. **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 understanding of the limitations.	PO5
6. **Communication:** Communicate effectively with diverse audiences and be able to prepare effective reports and design documentation.	PO10
7. **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):

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