SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

B.E. in Electrical and Electronics Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	HSMS		Management and Entrepreneurship	Dept.	3	0	0	3.5	3	50	50	100	3
2.	IPCC	S5EEI01	Electrical Machines-II	EEE	3	0	2	3.5	3	50	50	100	4
3.	IPCC	S5EEI02	Engineering Electromagnetics	EEE	3	0	2	3.5	3	50	50	100	4
4.	PCCL	S5EEL01	Computer Aided Electrical drawing	EEE	0	0	2	-	3	50	50	100	1
5.	PEC	N5EEPEXX	Professional Elective Course-I	EEE	3	0	0	3.5	3	50	50	100	3
6.	PROJ	S5EEMP	Mini Project / Extension Survey Project	EEE	0	0	4	-	3	100	-	100	2
7.	AEC		Research Methodology and IPR **(Board: IEM)**	ME, IM, CH	2	2	0	1.5	3	50	50	100	3
8.	HSMS	HS06	Environmental Studies **(Board: CV)**	CV	2	0	0	1.5	3	50	50	100	2
9.	NCMC		Soft Skills (Additional Course offered by SIT)	T&P	0	2	0	-	-	100	-	100	0
10.	NCMC	NS	National Service Scheme (NSS)	NSS CO	0	0	2			100	-	100	0
		PE	Physical Education (PE) (Sports and Athletics)	PED									
		YO	Yoga	PED									
			Total							**550**	**350**	**900**	**22**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **HSMS:** Humanity and Social Science and management Course **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course**; PROJ**: Project/Mini Project; **AEC**: Ability Enhancement Course; **NCMC**: Non-Credit Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)

S5EEPE01	FPGA based system design	S5EEPE03	Computer Networks
S5EEPE02	AI and Machine Learning	S5EEPE04	Advanced control theory

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

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester

to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

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

CIE procedure for Mini-project:

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

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

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

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B.E. in Electrical and Electronics Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S6EEI01	Power Electronics		3	0	2	3.5	3	50	50	100	4
2.	PCC	S6EE02	Power systems-I		3	2	0	3.5	3	50	50	100	4
3.	PEC	S6EEPEXX	Professional Elective Course-II		3	0	0	3.5	3	50	50	100	3
4.	OEC	S6EEPEXX	Open Elective Course-I		3	0	0	3.5	3	50	50	100	3
5.	PROJ	S6EEMP	Major Project Phase I		0	0	4	-	3	100	-	100	2
6.	PCCL	S6EEL01	Power systems laboratory		0	0	2	-	3	50	50	100	1
7.	AEC		Aptitude Related Analytical Skill		0	0	2	-	1½	50	50	100	1
8.	NCMC	NS	National Service Scheme (NSS)	NSS CO	0	0	2			100	-	100	0
		PE	Physical Education (PE) (Sports and Athletics)	PED									
		YO	Yoga	PED									
			Total							**500**	**300**	**800**	**18**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course**;**
OEC: Open Elective Course; **PROJ:** Project Phase –I; **PCCL**: Professional Core Course laboratory;
AEC: Ability Enhancement Course, **SEC**: Skill Enhancement Course; **NCMC**: Non-Credit Mandatory Course;
L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)

S6EEPE01	Special Electrical Machines	S6EEPE03	Electrical Power Quality
S6EEPE02	Smart Grid	S6EEPE04	Electrical Power Utilization

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vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.
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Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.
Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

VISION of the Institute

To develop thoughtful and creative young minds in a learning environment of high academic ambience by synergising spiritual values and technological competence.

MISSION of the Institute

1. To continuously strive for the total development of students by educating them in state-of-the-art-technologies and managerial competencies providing best in class learning experience with emphasis on skills, values and learning outcomes and helping them imbibe professional ethics and societal commitment.
2. To create research ambience that promotes interdisciplinary research catering to the needs of industry and society.
3. To collaborate with premier academic and research institutions and industries to strengthen multidisciplinary education, applied research, innovation, entrepreneurship and consulting ecosystems.

VISION of the Department

To be the premier center for education and research in Electrical and Electronics Engineering and to produce globally competent engineers with ethical values.

MISSION of the Department

- Develop as a center of Excellence for Electrical and Electronics Engineering education by providing the state-of –the-art infrastructure, industry relevant curriculum and effective teaching learning process.
- Contribute to the development of nation by pursuing research and development in the thrust areas of Electrical and Electronics Engineering such as Power Systems, Electrical Machines, Power Electronics and Renewable Energy Systems.
- Enable graduates to be professionally competent with strong ethical values.

PROGRAM EDUCTAIONAL OBJECTIVES (PEOs)

1. Pursuing successful career in the Electrical and Electronics Engineering and allied fields and opt for higher studies, research and to be an entrepreneur.
2. Designing solutions to Power System Engineering, Electrical Machines, Power Electronics and Renewable Energy Systems for specific industry applications and real-life problems using broad engineering knowledge.
3. Demonstrating professionalism, Ethical behavior and lifelong learning.

SCHEME & SYLLABUS
OF
V & VI SEMESTERS
B.E. ELECTRICAL & ELECTRONICS ENGINEERING
2024-25

(A) PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Analyze, Design and Assess the performance of Electrical Power System and its constituent equipment
2. Analyze, Design and Develop Power Electronic Systems

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ELECTRICAL MACHINES - II

Contact Hours/Week	:	3 (L)	Credits	:	3.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S5EEI01			

Course Objectives: This course will enable students to:

1	Illustrate the construction, principle and different operational aspects of 1-phase and 3-phase transformers.
2	Describe the working of 3-phase and 1-phase induction motors.
3	Interpret the performance parameters of 3-phase Induction motors.

Unit I

Transformers: Working Principle of transformer, Construction of transformers, shell and core type transformers, Ideal & practical transformers on no load, EMF equation, transformer on load, vector diagrams, equivalent circuit, losses, efficiency and regulation, all day efficiency, Numerical examples.
Testing: Polarity test, SC, OC test, and Sumpner's test. Separation of hysteresis and eddy current losses

9 Hrs

Unit II

Parallel operation: parallel operation of transformers & load sharing, numerical examples.
3-phase transformers: 3-phase transformer connection including open delta, choice of connection, bank of 1 phase transformers for three phase operation, phase conversion, Scott connection for 3phase-2phase conversion applications, three winding transformers with tertiary winding, equivalent circuit (Qualitative analysis only).

9 Hrs

Unit III

Autotransformers: Analysis Advantages/disadvantages. no load and on load tap changing transformers, numerical examples.
Analysis & performance of 3 phase induction motor: construction, classification & types of 3 phase induction motors, Concept of rotating magnetic field, operating principle. Induction motor on no load & load, efficiency and losses, vector diagram, concept of equivalent circuit.

8 Hrs

Unit IV

Performance characteristics, slip-torque characteristics covering regions of motoring, generating & braking. **Tests on IM:** No load & Blocked rotor tests, evaluation of equivalent circuit parameters, circle diagram & performance evaluation. Cogging & Crawling, equivalent circuit and performance of double cage & deep bar motors, induction generator - voltage buildup, applications.

8 Hrs

Unit V

Speed control: speed control – voltage, V/f & rotor resistance variations.

Starters: Need for starter, DOL, Y-Δ, rotor resistance starter, principle of autotransformer starter (Qualitative analysis only). **Single phase induction motor:** Double revolving field theory and principle of operation, types of 1 phase IM-split phase, capacitor start, shaded Pole motors.

8 Hrs

TEXT BOOKS:

1	Nagrath and Kothari.	Electrical Machines. TMH., 2017 5th Edition ISBN-10 935260640X, ISBN-13 978-9352606405
2	J B guptha	Theory & Performance of Electrical Machines, S.K. Kataria & Sons Publisher, 2013, ISBN-10 9350142775, ISBN-13 978-9350142776

REFERENCE BOOKS:

1	Kosow.	Electrical Machines and Transformers. Ed 2. PHI., 2007
2	Ashfaq husain	Electrical Machines. Dhanapatharai & Co., 2002
3	Langsdorf A.	Theory of alternating current Machine. TMH., 2001 2nd Edition-1. ISBN-13: 978-0070994232 ISBN-10: 0070994234
4	M.G.Say	Performance & Design of AC Machines. CBS Publishers., 2005. ISBN-13 978-8123910277

Integrated laboratory:

Sl. No.	List of Experiments
1	OC and SC tests on 1-phase transformer & pre-determination of efficiency & regulation for different loads & Power factor.
2	Pre-determination of efficiency of two identical transformers using Sumpner's Test
3	Polarity test & Parallel operation of two dissimilar 1-phase transformers
4	Connections of three 1- phase transformers in Star-Delta, star-star, delta-star and delta-delta configurations and to observe the performance.
5	Scott connection for balanced and unbalanced two phase UPF loads
6	Load test on three phase Induction motor – performance evaluation (Torque-speed, BHP-efficiency, BHP-PF, Slip-BHP)
7	Performance evaluation of 3-phase Induction Motor using Circle Diagram
8	Determination of equivalent circuit and performance evaluation of 3 phase Induction motor
9	Speed control of three phase slip ring Induction motor using stator voltage control and rotor resistance control
10	Load test on 1- phase Induction motor.

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Analyse** equivalent circuit parameters and draw phasor diagrams to determine the voltage regulation and efficiency of transformer.
CO2	**Estimate** the load sharing of transformers when they are operating in parallel.
CO3	**Distinguish** various aspects of different three phase transformer connections.

CO4	**Illustrate** the operating principles of auto transformer in comparison with single phase transformer.
CO5	**Evaluate** circle diagram and equivalent circuit using test data and evaluate the performance parameters of three phase induction motor and study different types of single-phase induction motors.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	2	1						1				2	
	CO2	3	2	1						1				2	
	CO3	3	3	1						1				3	
	CO4	3	3	1						1				3	
	CO5	3	3	1						1				3	

ENGINEERING ELECTROMAGNETICS

Contact Hours/Week	:	3 (L)	Credits	:	3.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S5EEI02			

Course Objectives: This course will enable students to:

1	Understand basic concepts of electromagnetic field theory.
2	Explain applications of electromagnetic field theory in electrical engineering such as electrical machines and wave propagation.

Unit I

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

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

9 Hrs

Unit II

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

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

9 Hrs

Unit III

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

8 Hrs

Unit IV

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

8 Hrs

Unit V

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

8 Hrs

TEXT BOOKS:

1	Matthew N O Sadiku	Elements of Electromagnetics, Oxford University Press, Edition 6, 2015, ISBN 0199321388, 9780199321384

REFERENCE BOOKS:

1	William H Jr. Hayt and John A Buck	Engineering Electromagnetics, Tata McGraw-Hill Education, Edition 7, 2006, ISBN 0070612234, 9780070612235
2	Joseph Edminster, Schaum	Outline of Electromagnetics, McGraw Hill Professional, Edition 3, 2010, ISBN 0071632344, 9780071632348
3	A. Pramanik	Electromagnetism - Theory and applications, PHI Learning Pvt. Ltd, Edition 2, 2008, ISBN 8120334655, 9788120334656
4	A. Pramanik	Electromagnetism-Problems with solution, PHI Learning Pvt. Ltd., Edition 3, 2012, ISBN 8120346335, 9788120346338

Integrated Lab

List of Experiments:

1. Plotting of Electric field lines for different configurations – Parallel plate, and Coaxial cable.
2. Variation of Electrostatic Field over multiple dielectrics.
3. Determination of Capacitance of cable.

4. Capacitive grading in condenser bushings.
5. Determination of Inductance of solenoid and coaxial cable.
6. Determination of leakage reactance of Transformer.
7. Force on a single current carrying conductor.
8. Determination of torque-speed characteristics of Induction motor(Demonstration).
9. **Course Outcomes:** After the completion of this course, students will be able to:

CO1	**Compute** electrostatic field due to different charge distributions by using Coulomb's law and Gauss' law.
CO2	**Compute** potentials due to different charge distributions and solve one dimensional boundary value problems
CO3	**Apply** Biot-savart's law, Ampere's law, and concept of vector magnetic potential to solve magneto static problems
CO4	**Compute** Magnetic Forces and inductance of simple examples.
CO5	**Apply** Maxwell's equations to solve time varying electromagnetic field problems.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	2	-	-	2	-	-	-	-	-	-	-	3	
	CO2	3	2	2	-	2	-	-	-	-	-	-	-	3	
	CO3	2	2	2	-	2	-	-	-	-	-	-	-	3	
	CO4	2	2	3	-	2	-	-	-	-	-	-	-	3	2
	CO5	2	2	2	-	2	-	-	-	-	-	-	-	3	2

COMPUTER AIDED ELECTRICAL DRAWING

Contact Hours/Week	:	2 (P)	Credits	:	1.0
Total Lecture Hours	:	--	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	N5EEL01			

Course Objectives: This course will enable students to:

1. Acquire in-depth knowledge of single line diagrams of receiving stations and Sub-stations.
2. Compile the concepts of AC and DC windings.
3. Interpret the assembly of various parts of AC and DC machines.

List of Experiments:

1. Various symbols used in Electrical Engineering Drawing and to draw single line diagrams of receiving stations and sub-stations.
2. Developed winding diagram of DC Duplex double layer progressive Lap Winding.
3. Developed winding diagram of AC double layer Integral slot full-pitch lap Winding.
4. Developed winding diagram of AC double layer Integral slot short-pitch lap Winding.
5. Sectional views of Cruciform & multi-stepped core sections of Transformer

6. Sectional view of single-phase core type transformer.
7. Sectional view of Rotor of a Squirrel-cage Induction motor.
8. Sectional view of Stator of a Squirrel-cage Induction motor.
9. Sectional view of Salient-pole type Rotor of an Alternator.
10. Sectional view of cylindrical type Rotor of an Alternator.

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Analyse** the importance of single line diagram of substations and receiving Stations.
CO2	**Apply** the concepts of AC and DC windings and to draw the developed winding diagrams.
CO3	**Model** the cross-sectional views and summarise the parts of AC and DC Machines.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	3										2	2
	CO2	3	3	2		2								2	
	CO3	3	3		2	3								3	

Professional Elective
Course-I

FPGA BASED SYSTEM DESIGN

Contact Hours/ Week : 3(L) Credits: 3

Total Lecture Hours	: 42	CIE Marks: 50
Total Tutorial Hours	: -	SEE Marks: 50
Course Code	: S5EEPE01	

Course Objectives: This course will enable students to:

1. Interpret FPGA architecture, interconnect and technologies and implementation methodologies.
2. Understand configuring and implementing digital embedded system on FPGA**.**

Unit I

FPGA based system design: Introduction, The Role of FPGAs, FPGA Types, FPGAs vs. Custom VLSI, FPGA-Based System Design- Goals and Techniques, Hierarchical Design, Combinational Circuits, Sequential Circuits, Timing, Electrical Characteristics, Power Dissipation.

8 Hrs

Unit II

FPGA Fabrication: FPGA Architectures, SRAM-Based, Logic Elements, Interconnection Networks, Configuration, Permanently Programmed FPGAs, Circuit Design of FPGA Fabrics, Interconnect Architecture.

Current state of the field: SoC, IP Design, SoPC, Design methodology, System Modeling, Hardware Software Co-design, Device Technology, Application Domains

8 Hrs

Unit III

Programmable Logic Devices: Introduction, Evolution of PROM, PLA, PAL, Architecture of PAL's, Applications. Programming PLD's, Design Flow, Programmable Interconnections, Complex PLD's (MAX - 7000, APEX), Architecture, Resources, Applications, Tools.

9 Hrs

Unit IV

VHDL for Synthesis: Introduction. Behavioral, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inferencing, Test bench.

8 Hrs

Unit V

DFPGA's: Introduction, Logic Block Architecture, Routing Architecture, Programmable Interconnections, Design Flow, Xilinx Virtex-II, Altera Stratix, Actel 54SX Architecture. Static Timing Analysis, Applications.

9 Hrs

Text books:

1.	W.Wolf	"FPGA based system design", Pearson, 2004, ISBN-13: 978-8131724651

Reference books:

1.	Clive Maxfield	The Design Warriors's Guide to FPGAs", Elsevier, 2004. ISBN-13: 978-

		0750676045
2.	NPTEL LINK	https://nptel.ac.in/courses/117108040/

Course Outcomes: After the completion of this course, students will be able to:

1. **Design** configurable digital system using FPGA
2. **Interpret** the FPGA Architecture and fabrication.
3. **Design** and model digital circuits with PLD's
4. **Implement** digital circuits in FPGA processor using VHDL.
5. **Interpret** the architecture and features of DFPGA.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	2	2	3											3
	CO2	3	2												2
	CO3	3	2	3											3
	CO4	3	2	3											3
	CO5	3	2												2

AI AND MACHINE LEARNING

Contact Hours/Week	:	3 (L)	Credits	:	3.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S5EEPE02			

Course Objectives: This course will enable students to:

1	Explain the concept of Artificial Intelligence and problem solving.
2	Understand advanced problem-solving paradigms and knowledge representation.
3	Explore neural networks and build neural networks to solve various classification problems.

Unit I

Introduction, Problem Solving: state space search and control strategies: Introduction, General problem solving, Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Interactive Deepening, Constant satisfaction.

8 Hrs

Unit II

Problem reduction and Game playing, Logic concepts and logic programming: Introduction, Problem reduction, Game playing, Bounded look ahead strategy and Use of, Alpha-Beta Pruning, Two – player perfect information games. Propositional calculus, Propositional logic, Natural Deduction system,

Axiomatic system, Semantic tableau system in propositional logic, resolution refutation in propositional logic, Predicate logic, Logic programming

9 Hrs

Unit III

Advanced problem-solving paradigm: planning-types of planning systems, Block world problem, logic-based planning, Linear planning using a goal stack, Means-ends analysis, Non-linear planning strategies. Knowledge representation: Approaches to knowledge representation, knowledge representation using semantic network, Extended semantic networks for KR, Knowledge representation using frames.

9 Hrs

Unit IV

Uncertainty Measure: Probability Theory, Bayesian Belief Networks, Machine Learning Paradigms: Machine learning system, supervised and unsupervised learnings, Inductive, deductive learning, Clustering.

8 Hrs

Unit V

Support vector Machine, case-based reasoning and learning. ANN: Single Layer, Multilayer. RBF, Design issues in ANN, Recurrent Network

8 Hrs

Text books:

1	Saroj Kaushik	Artificial Intelligence, Cengage Learning, 2nd Edition, 2022, ISBN: 9789355730428.

Reference books:

1	George F Luger	Artificial Intelligence, Structures and Strategies for Complex Problem Solving, Pearson Addison Wesley 6th Edition, 2008, ISBN-13: 978-0-321-54589-3 (alk. paper)
2	E Rich, K Knight, and S B Nair	Artificial Intelligence, Tata Mc-Graw Hill 3rd Edition, 2009, ISBN:978-0070087705
3	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig Prentice Hall 3rd Edition, 2009. ISBN- 978-0136042594

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Analyse** problems for AI. Characterize the search techniques to solve problems and recognize the scope of classical search techniques.
CO2	**Interpret** the role of knowledge in AI.
CO3	**Demonstrate** the use of Logic in solving AI problems.
CO4	**Illustrate** uncertain knowledge with suitable example and reasoning in probability theory.

CO5	**Elucidate** different Learning methods in AI.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	3										2	2
	CO2	3	3	2	2	1								2	2
	CO3	3	3	2	2	2								2	2
	CO4	3	3	2	2	2								2	2
	CO5	3	3	3	2	1								2	2

COMPUTER NETWORKS

Contact Hours/ Week	: 3(L)	Credits:	3
Total Lecture Hours	: 42	CIE Marks:	50
Total Tutorial Hours	: -	SEE Marks:	50
Course Code	: S5EEPE03		

Course Objectives: This course will enable students to:

1. Understand general-purpose computer networks.
2. Comprehend the principles and concepts on computer networks.

Unit I

INTRODUCTION: Data Communications; Networks; the Internet; Protocols and Standards; Layered tasks; The OSI Model and the layers in the OSI model; TCP / IP Protocol Suite.

8Hrs

Unit II

DATA, SIGNALS, AND DIGITAL TRANSMISSION: Analog and digital signals; Transmission impairment; Data rate limits; Performance; Digital-to-Digital conversion; Analog-to-Digital conversion; Transmission modes.

ANALOG TRANSMISSION AND MULTIPLEXING: Digital - to - Analog conversion; Analog - to - Analog conversion; Multiplexing; Spread spectrum.

9 Hrs

Unit III

TRANSMISSION MEDIA, ERROR DETECTION AND CORRECTION: Twisted pair cable, Coaxial cable, Fibre-Optic cable, Radio waves, Microwaves, Infrared. Introduction to error detection / correction; Block coding; Linear block codes; Cyclic codes, Checksum.

DATA LINK CONTROL: Framing; Flow and Error control; Protocols; Noiseless channels; Noisy channels; HDLC; Point-to-point Protocol - framing, transition phases.

8Hrs

Unit IV

MULTIPLE ACCESS, ETHERNET: Random Access; Controlled Access; Channelization. Ethernet: IEEE standards; Standard Ethernet and changes in the standard; Fast Ethernet; Gigabit Ethernet.

8Hrs

Unit V

WIRELESS LANS AND CONNECTION OF LANS: IEE 802.11; Bluetooth. Connecting devices; Backbone Networks; Virtual LANs.

OTHER TECHNOLOGIES: Cellular telephony; SONET / SDH: Architecture, Layers, Frames; STS multiplexing. ATM: Design goals, problems, architecture, switching, layers.

9 Hrs

Text books:

1.	Behrouz A. Forouzan	Data Communications and Networking, Tata McGraw-Hill, 4th Edition, 2006. ISBN-13: 978-0070634145

REFERENCE BOOKS:

1.	Alberto Leon, Garcia and Indra Widjaja	Communication Networks: Fundamental Concepts and Key Architectures, Tata McGraw- Hill, 2nd Edition, 2004. ISBN-13: 978-0070595019

Course Outcomes: After the completion of this course, students will be able to:

1. **Summarize** the classification of network services, protocols and architectures.
2. **Analyze** key Internet applications and their protocols.
3. **Interpret** concepts of MAC protocols and demonstrates wireless Lan.
4. **Design** and analysis of the routing Protocols.
5. **Articulate, analyse** the connection oriented and connection less protocols.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	2											**2**	2
	CO2	3	3											**2**	2
	CO3	3	3											**2**	2
	CO4	3	3	3										**2**	2
	CO5	3	2											**2**	2

ADVANCED CONTROL THEORY

Contact Hours/ Week	: 3(L)	Credits:	3
Total Lecture Hours	: 42	CIE Marks:	50
Total Tutorial Hours	: -	SEE Marks:	50
Course Code	: S5EEPE04		

Course Objectives: This course will enable students to

1. Study different representations of systems using state variables.
2. Obtain transfer function from state model and to give a deep insight into state equations, STM and its properties.
3. Understand the importance of PI, PD and PID controllers in the design of system and with the concepts of controllability and observability of systems.

Unit I

State variable analysis: Introduction, Concept of state, State variables, and state model of linear systems, Linearization of state equation.

State space Representation using physical variables, phase variables and canonical variables. Diagonalisation, Eigen values and Eigen vectors, Generalized Eigen vectors.

9Hrs

Unit II

State variable analysis (Continued): Derivations of Transfer function from state model. Solution of state equation, state transition matrix & its properties, computation using Laplace transformation, Cayley-Hamilton method.

8Hrs

Unit III

Controllability and observability: Basic concepts, Kalman's test, Gilberts test, Duality property, Effect of pole-zero cancellation on controllability and observability.

8Hrs

Unit IV

Pole placement Design: Introduction, Stability improvements by state feedback, Necessary and sufficient conditions for arbitrary pole placement. State Regulator design, Design of state Observers.

8Hrs

Unit V

Non-linear systems: Introduction, Common physical non-linearities. Phase plane method. singular points, stability of non-linear systems. Limit Cycles. Construction of phase trajectories.

9Hrs

Text books:

1.	M.Gopal	Digital Control and State Variable Methods, 2nd ed, Tata Mc Graw Hill, 2003
2.	I.J.Nagrath and M.Gopal	Control System Engineering", New Age International, 2008.

Reference books:

1.	Katsuhiko Ogata	State Space Analysis of Control Systems, Prentice Hall Inc., 1967
2.	Benjamin C Kuo and FaridGolnaraghi	Automatic Control Systems", 8th ed., John Wiley & Sons, 2003.
3.	Katsuhiko Ogata	Modern Control Engineering, 4th ed., PHI/Pearson Education, 2002.
4.	M.N.Bandyopadhyay	Control Engineering, PHI, 2003
5.	Tokel Glad & Lennart L Jung	Control Theory, CRC press, 2003

Course Outcomes: After the completion of this course, students will be able to:

1. **Illustrate** state models of systems and represent systems in different state variable configurations.
2. **Compute** solution of state equation using different methods.
3. **Analyse** PI, PD and PID systems and assess controllability and observability of system.
4. **Implement** pole placement design and state observer design.
5. **Interpret** various nonlinearities.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

	POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2

COs	CO1	3	2											**2**	2
	CO2	3	3											**2**	2
	CO3	3	3											**2**	2
	CO4	3	3	3										**2**	2
	CO5	3	2											**2**	2

ENVIRONMENTAL SCIENCE

Contact Hours/ Week	: 2(T)	Credits:	2.0
Total Lecture Hours	: ---	CIE Marks:	50
Total Tutorial Hours	: 28	SEE Marks:	50
Course Code	: HS06		

Course Objectives: This course will enable students to:

1.	The problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2.	Different types of energy- renewable, non-renewable and energy conservation, impact of environmental pollution, solid waste management - disposal, treatment of different types of solid waste including MSW and e-waste.
3.	Societal impacts of environmental issues - ozone layer depletion, GHG effects, and water conservation.

Unit I

Introduction: Components of Environment and their interactions

Natural Resources: Forest Resources - Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions, Water resources, Types of water reserves, Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types

3Hrs

Unit II

Energy and resources: Types of Energy - Renewable, Non-renewable & sustainable energy & their advantages and disadvantages, Renewable energy sources - Solar energy, Wind energy, Biomass energy, Thermal power - environmental impacts, Hydrogen energy, Tips for conservation of energy

3 Hrs

Unit III

Environmental pollution: Sources of pollution- Natural and anthropogenic sources

• Pollutants - Classification & their effects on environment

• Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human

health and climate, Water quality – Potable water, Wholesome water, Sources of water pollution
• Common impurities in water, Effects of impurities on human health, Soil Pollution – Sources, effects and its control

3 Hrs

Unit IV

Solid Waste Management:
• Definition of solid waste, refuse, garbage, rubbish, ash. Types of solid waste
• Municipal solid waste and the necessity of its safe disposal, Impacts on human health and environment
• Quantity and composition of MSW
• Disposal of solid waste
• E-waste – Types and health effects

3 Hrs

Unit V

Sustainable development
• Global environmental issues: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures
• Issues on energy utilization, water conservation, concept of 3 Rs, Rainwater harvesting - methods

3 Hrs

TEXT BOOKS:

Sl. No.	Title of the Book	Author/s	Publisher	Year
T1	Joseph, B. (2009). Environmental Studies. India: Tata McGraw-Hill. ISBN: 9781283922524			
T2	Tripathi, A. K. (2016). Environmental Studies. India: Energy and Resources Institute. ISBN:9788179935828			
R1	Akitsu, T. (2018). Environmental Science: Society, Nature, and Technology. Singapore: Jenny Stanford Publishing. ISBN: 9780429468230			

Course Outcomes: After the completion of this course, students will be able to:

CO1	Describe the interactions between components of environment, importance of water and land resources, effects of deforestation and land degradation
CO2	Describe the need for renewable sources to address the present world's energy demand
CO3	Describe the effects of pollution of air, water, soil, and its control
CO4	Describe the composition of solid waste, its impact on environment and its safe disposal
CO5	Describe the current environmental issues, the need for sustainable development, and its importance in the present world

Question paper pattern:

The question paper pattern for CIE and SEE is as follows:

Test 1	25 Marks	45 Minutes	• 10 Marks (Multiple Choice Questions)
Test 2	25 Marks	45 Minutes	• 3 Descriptive Questions of 5 Marks each

SEE	50 Marks	90 Minutes	• 20 Marks (Multiple Choice Questions) • 30 Marks (Descriptive Questions of 6 Marks each)

POWER ELECTRONICS

Contact Hours/Week	:	3 (L) +2(P)	Credits	:	4.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S6EEI01			

Course Objectives: This course will enable students to:

1	Understand the working and characteristics of various power devices.
2	Study and analysis of thyristor circuits with different triggering techniques.
3	Learn the applications of power devices in controlled rectifiers, converters and inverters.

Unit I

Introduction: Applications of Power Electronics, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits, Peripheral Effects. Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics, di/dt and dv/dt limitations. Introduction to SiC and GaN power devices.

8 Hrs

Unit II

Thyristors: Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, two transistor model of SCR, Gate Characteristics of SCR, Turn-On and Turn-Off Methods, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit, UJT Firing Circuit.

9 Hrs

Unit III

Controlled Rectifiers: Introduction, Principle of Phase-Controlled Converter Operation, Single-Phase Full Converter with R and RL Load, Single-Phase Dual Converters, Single-Phase Semi Converter with RL load. **AC Voltage Controllers:** Introduction, Principles of ON-OFF Control, Principle of Phase Control, Single phase controllers with resistive and inductive loads.

9 Hrs

Unit IV

DC-DC Converters: Introduction, principle of step-down operation and analysis with R and RL load,

principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators.

8 Hrs

Unit V

Inverters: Introduction, Principle of operation, performance parameters, single phase bridge inverters, Voltage control of single-phase inverters (linear modulation over modulation square wave operation), PWM technique-SPWM, MSPWM, Three phase inverters (120° and 180°conduction). Introduction to multilevel inverters and types of multilevel inverters.

8 Hrs

Text books:

1	Mohammad H Rashid	Power Electronics, Circuits, Devices and Applications, 3rd/4th Edition, Pearson Education Inc, 2014, ISBN: 978-93-325-1844-5.
2	M.D Singh and K B Khanchandani	Power Electronics, 2nd Edition, Tata Mc-Graw Hill, 2009, ISBN: 0070583897

Reference books:

1	L. Umanand	Power Electronics, Essentials and Applications, John Wiley India Pvt. Ltd, 2009.
2	Dr. P. S. Bimbhra	Power Electronics, Khanna Publishers, Delhi, 2012.
3	P.C. Sen	Modern Power Electronics‖, S Chand & Co New Delhi, 2005.

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Analyse** the characteristics of different power devices and illustrate various applications associated with it.
CO2	**Analyse** the output response of a thyristor circuit with various triggering options.
CO3	**Analyse** the response of controlled rectifier with resistive and inductive loads.
CO4	**Analyse** the operation of as DC-DC converters and inverters
CO5	**Analyse** and **interpret** the working of power electronic devices and circuits.

Integrated Lab

Sl. No.	**Experiments**
1	Static characteristics of SCR and TRIAC
2	Static characteristics of MOSFET and IGBT.
3	Controlled HWR using RC Triggering circuit.

4	Single phase FWR with R, RL and motor load.
5	Speed control of a separately excited DC motor using an IGBT/MOSFET chopper (Four quadrants)
6	Single phase PWM Inverter
7	Three phase full wave bridge inverter circuit.
8	Speed control of a single-phase induction motor
9	Buck and Boost DC-DC converter
10	Three phase full wave bridge converter

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	2												2
	CO2	3	3	1											3
	CO3	3	3	1											3
	CO4	3	2	2											3
	CO5	3	1												3

POWERS SYSTEMS-I

Contact Hours/Week	:	3(L)	Credits	:	3
Total Lecture Hours	:	42	CIE Marks	:	50
Course Code	:	S6EE02	SEE Marks	:	50

Course Objectives: This course will enable students to

1. Represent power system using single line diagram and carryout fault studies of a power system.
2. Understand the symmetrical components and power system stability.

Unit I

Representation of Power System Components: One line-diagram, impedance & reactance diagrams. Per unit system. The steady state model of Synchronous machine, Representation of Load.

8 Hrs

Unit II

Symmetrical 3 Phase faults: Transients on a Transmission Line, Short Circuit of a Synchronous machine (On No Load), Short Circuit of a Loaded Synchronous Machine, Selection of Circuit Breakers.

8 Hrs

Unit III

Symmetrical components: Resolution of unbalanced phasors into their symmetrical components. Phase shift of symmetrical components in star-delta transformer bank. Power in terms of symmetrical components. Sequence circuits of power system elements (alternator, transformer and transmission line). Measurement of sequence impedances of synchronous generator, Sequence Networks.

8 Hrs

Unit IV

Unsymmetrical faults: Symmetrical component analysis of Unsymmetrical faults on an unloaded alternator with and without fault impedance, Symmetrical component analysis of Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults, Neutral grounding.

9 Hrs

Unit V

Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability, Multi machine stability studies, classical representation.

9 Hrs

Text books:

1.	W.D. Stevenson and Grainger	Power System Analysis, TMH
2.	Nagrath and D. P. Kothari	Modern Power System Analysis, Tata McGraw - Hill. 2/e.

Reference books:

1.	Hadi Sadat	Power system Analysis, TMH
2.	Bergen Arthur R	Power system analysis, 2nd edition, Pearson Education
3.	GL Kusic	Computer Aided power system analysis, PHI

Course Outcomes: After the completion of this course, students will be able to:

1. **Illustrate** power system network components in the form of single line diagram by computing per unit values
2. **Analyze** the effects of three phase faults occurring at the terminals of loaded and unloaded synchronous generators.
3. **Compute** unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks.
4. **Analyze** the unsymmetrical faults occurring in different power system components using the concept of symmetrical components
5. **Analyze** dynamics of synchronous machine and determine the power system stability.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	3										2	-
	CO2	3	3	2										2	-

	CO3	3	3	2									2	-
	CO4	3	3	2									2	-
	CO5	3	3	3									2	-

POWER SYSTEMS LABORATORY

Contact Hours/Week	:	2(P)	Credits	:	1.0
Total Lecture Hours	:	--	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	N6EEL01			

Course Objectives: This course will enable students to:

1	Assess the performance of medium and long transmission lines.
2	Understand the power angle characteristics of salient and non- salient pole alternator.
3	Perform fault studies for simple radial power systems.

Sl. No.	List of Experiments
1	Formation for symmetric π /T configuration for Verification of AD-BC=1, Determination of Efficiency and Regulation.
2	To determine fault currents & voltages in a transmission line system with transformers, at a specified location for SLGF.
3	To determine fault currents & voltages in a transmission line system with transformers, at a specified location for LLF.
4	To determine fault currents & voltages in a transmission line system with transformers, at a specified location for DLGF.
5	Study of symmetrical three phase fault
6	Determination of Power Angle Diagrams, Reluctance Power, Excitation, Emf and Regulation for Salient and Non-Salient Pole Synchronous Machines
7	To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines. (Sustained fault)
8	To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.(Fault cleared)
9	Optimal Generation Scheduling for Thermal power plants by simulation.
10	Open ended experiments on study of power system network.

Course Outcomes: After the completion of this course, students will be able to:

CO1	Develop a program in MATLAB to assess the performance of medium and long transmission lines.
CO2	Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.
CO3	Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a of radial power systems.
CO4	Analyze unsymmetrical faults at different locations in radial power systems using MATALAB software
CO5	Analyze optimal generation scheduling problems for thermal power plants using MATALAB software

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	3										2	1
	CO2	3	3	2	2	1								2	1
	CO3	3	3	2	2	2								2	1
	CO4	3	3	2	2	2								2	1
	CO5	3	3	3	3	2								2	1

PROFESSIONAL ELECTIVE
COURSE-II

SPECIAL ELECTRICAL MACHINES

Contact Hours/Week	:	3 (L)	Credits	:	3.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S6EEPE01			

Course Objectives: This course will enable students to

1	Assess the performance of modern electrical machines.
2	Describe special electrical machines.

Unit I

Stepper Motor: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types of Stepper Motor, Windings in Stepper Motors, Torque Equation, Characteristics of Stepper Motor, Open – loop Control of Stepper Motor, Closed – loop Control of Stepper Motor, Microprocessor – Based Control of Stepper Motor, Applications of Stepper Motor.

9 Hrs

Unit II

Switched Reluctance Motor (SRM): Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Microprocessor based Control of SRM, Sensorless Control of SRM.

9 Hrs

Unit III

Permanent Magnet DC Motor: Construction, performance characteristics, Moving coil motors. **Brushless Permanent Magnet DC Motor: C**lassification, construction, electronic commutation, BLDC square wave motor, Difference between mechanical and electronic commutators- Hall sensors, Optical sensors, Torque and E.M.F equation, Torque-speed characteristics, Power Controllers-Drive Circuits, Applications.

8 Hrs

Unit IV

Permanent Magnet Synchronous Motor (PMSM): Construction, Principle of Operation, EMF Equation, Torque Equation, Phasor Diagram, Circle Diagram, Comparison of Conventional and PMSM, Control of PMSM, Applications. **Synchronous Reluctance Motor (SyRM):** Constructional of SyRM, Working, Phasor Diagram and Torque Equation, Control of SyRM, Advantages and Applications

8 Hrs

Unit V

Single Phase Special Electrical Machines: AC series Motor, Repulsion Motor, Hysteresis Motor, Single Phase Reluctance Motor, Universal Motor. **Servo Motors:** DC Servo Motors, AC Servo Motors. **Linear Electric Machines:** Linear Induction Motor, Linear Synchronous Motor, DC Linear Motor, Linear Reluctance Motor, Linear Levitation Machines.

8 Hrs

Text books:

1	Janardhan E.G.	Special Electrical Machines, 1st Edition, ISBN-13 978-8120348806, Prentice Hall India Learning Private Limited
2	K. Venkataratnam	Special Electrical Machines, 1St Edition, ISBN-13 978-1439806463 CRC Press Inc CRC press

Reference books:

1	M.G. Say	Performance & design of AC Machines. CBS, New Delhi.
2	R.K. Aggarwal	Principles of electrical machine design, S.K. Kataria & Sons. Delhi.

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Summarize** the working principle of Stepper motor, SRM, PMDC motors.
CO2	**Illustrate** the working principle of single phase, servo, linear electric motors.
CO3	**Analyze** various characteristics of special electrical machines.
CO4	**Analyze** the control of special electrical machines.
CO5	**Analyse** suitable special electrical machine for a particular application.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2
	CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	2
	CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	3
	CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	3
	CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	2

SMART GRID

Contact Hours/ Week	: 3(L)	Credits: 3
Total Lecture Hours	: 42	CIE Marks: 50
Total Tutorial Hours	: -	SEE Marks: 50
Course Code	: S6EEPE02	

Course Objectives: This course will enable students to:

1. Develop the practical insight about the modernization of Electrical Power System.
2. Understand several issues involved in realization of Smart Grid.

Unit I

Introduction to Smart Grid: Evolution of Electric Grid, Evolution of Indian National Grid, Regulatory authorities in Indian Power sector, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Present development & International policies in Smart Grid.

8 Hrs

Unit II

Smart Substations: Substation Automation equipment-block diagram, Intelligent electronic devices: Bay controller, Remote terminal units, Faults in the distribution system, Components for fault isolation and restoration,Fault location, isolation and restoration, Voltage regulation.

9 Hrs

Unit III

Sensing, Measurement, Control and Automation Technologies: Smart metering: Key components of smart metering, overview of the hardware used, Signal acquisition, Signal conditioning, Analogue to digital conversion, Computation, Input/output, Communication. **Communications infrastructure and protocols for smart metering:** Home-area network, Neighborhood area network, Data concentrator, Meter data management system, Protocols for communications, Demand-side integration, Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations, Flexibility delivered by consumers from the demand side.

8 Hrs

Unit IV

Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues. **Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, PowerQuality monitoring, Power Quality Audit.

8 Hrs

Unit V

Micro Grid: Power system resilience, The concept of micro-grids, Types of micro grids, Autonomous and non-autonomous grids, Sizing of micro-grids, Microgrid Modeling & Analysis, Micro-grids with multiple DGs. Standards and regulation issues associated with AC & DC microgrids, Comparison between AC and DC Micro grids.

9 Hrs

Text books:

1	Janaka Ekanayake Kithsiri Liyanage Jianzhong Wu Akihiko Yokoyama	Smart Grid: Technology and Applications, 1st Edition, Wiley, 2015, ISBN-13: 978-8126557356

Reference books:

1.	James Momoh Smart Grid,	Fundamentals of Design and Analysis Wiley 1st Edition, 2012, ASIN: B01JXWU4U6
2.	NPTEL LINK https://nptel.ac.in/course	s/108107113/

Course Outcomes: After the completion of this course, students will be able to:

1. **Identify** progress made by different stakeholders in the design and development of smart grid.
2. **Classify** measurement techniques using Phasor Measurement Units and smart meters.
3. **Explain** tools for the analysis of smart grid and design, operation and performance.
4. **Categorize** classical optimization techniques and computational methods for smart grid design, planning and operation and explain predictive grid management and control technology for enhancing the smart grid performance.

5. **Develop** cleaner, more environmentally responsible technologies for the electric system.
6. **Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes**

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	2											3	1
	CO2	3	3											3	1
	CO3	3	3											3	1
	CO4	3	3											3	1
	CO5	3	2											3	1

ELECTRIC POWER QUALITY

Contact Hours/ Week	: 3(L)	Credits:	3
Total Lecture Hours	: 42	CIE Marks:	50
Total Tutorial Hours	: -	SEE Marks:	50
Course Code	: S6EEPE03		

Course Objectives: This course will enable students to:

1. Characterize the different Power Quality disturbance and impact on power system equipment.
2. Evaluate the harmonics and design the suitable harmonic mitigation technique.
3. Characterize the voltage variation events and asses their impact on power system components.

Unit I

Introduction to Power Quality Disturbances: Understanding Power quality, types of power quality disturbances, power quality indices, Causes and effects of power quality disturbances

8 Hrs

Unit II

Harmonics: Causes and effects of harmonics, converter configuration and their contribution to supply harmonics, other sources of harmonics, Radio interference, supply standards, elimination/suppression of harmonics, classical solutions & their drawbacks, passive input filters, transformer connections.

8 Hrs

Unit III

Active Filters: Elimination/suppression of harmonics using active power filters - topologies, and their control methods, PWM converter as a voltage source active filter, current source active filter, constant

tolerance band control, variable tolerance band control

9 Hrs

Unit IV

Short Interruptions and Voltage Sag: Short Interruptions: Introduction, terminology, origin of short interruptions, monitoring of short interruptions, influence on equipment, single phase tripping, stochastic prediction of short interruptions. **Voltage Sags - Characterization:** Introduction, voltage sag magnitude, voltage sag duration, three phase unbalance, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, other characteristic of voltage sags, load influence on voltage sags, sag due starting of induction motors.

8 Hrs

Unit V

Mitigation of Interruptions and Voltage Sags: Voltage Sags – Equipment Behavior: Introduction, computers and consumer electronics, adjustable speed AC drives, adjustable speed DC drives, other sensitive load. Overview of mitigation methods, power system design – redundancy through switching and parallel operation, system equipment interface.

9 Hrs

Text book:

1.	Mahesh Kumar Mishra	Power Quality in Power Distribution Systems Concepts and Applications, CRC Press, Taylor and Francis Group, A Chapman and Hall Book 1st Edition, 2023, ISBN-13-978-0367750916, ISBN-10-0367750910.

Reference books:

1.	R.C. Dugan	Power Quality, TMH, 2012
2.	A.J. Arrillga and Watson	Power system harmonics, John Wiley and Sons, 2004
3.	Math H J Bollen	Understanding Power Quality Problems; Voltage Sags and Interruptions, Wiley India, 2011

Course Outcomes: After the completion of this course, students will be able to:

1. **Interpret** the Electrical power quality issues, their Characterization, causes and consequences on power system.
2. **Interpret** the Characterization of harmonics and its effect on power system, suppression of harmonics by classical methods and Design suitable filters.
3. **Analyze** the principle of suppression oh harmonics by Active filters, Interpret the configuration and operation of Active filters.
4. **Interpret** the Characterization of Short Interruptions and Voltage Sag and its effect on power system.
5. **Analyze** the principle of Elimination/ suppression techniques of interruption and voltage sag.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

	POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2

COs	CO1	2	3											2	2
	CO2	2	3	3										2	2
	CO3	2	3											2	2
	CO4	2	3											2	2
	CO5	2	3											2	2

ELECTRICAL POWER UTILIZATION

Contact Hours/Week	:	3 (L)	Credits	:	3.0
Total Lecture Hours	:	42	CIE Marks	:	50
Total Tutorial Hours	:	--	SEE Marks	:	50
Course Code	:	S6EEPE04			

Course Objectives: This course will enable students to

1	Impart knowledge on electrical energy-based heating and welding.
2	Impart how to design the traction system considering economic and technology upgradation.
3	Explore working of electric and hybrid electric vehicles technology.

Unit I

Heating and welding: Advantages and method of electric heating, resistance heating, Induction heating, dielectric heating, the arc furnace, heating of building, electric welding, resistance and arc welding, Ultrasonic welding, Electric welding equipment.

9 Hrs

Unit II

Electrolytic process: Fundamental principles, extraction, refining of metals, electroplating, factors affecting electro deposition process. **Electric traction:** Introduction, requirements of an ideal traction, System of traction, speed time curve, tractive effort, co-efficient of adhesion, selection of traction motors, method of speed control, energy saving by series parallel control.

8 Hrs

Unit III

Electric traction: AC traction, AC traction equipment, AC series motor characteristics, regenerative braking, linear induction motor and their use, Diesel electric equipment, train lighting system, Specific energy, Factors affecting specific energy consumption.

9 Hrs

Unit IV

Illumination: Laws of illumination, distribution and control of lighting, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps-incandescent, fluorescent, vapour,

CFL, LED and their working, comparison, Glare and its remedy.

8 Hrs

Unit V

Introduction to Electric and Hybrid Vehicles: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies.

8 Hrs

Text books:

1.	Openshaw Taylor	Utilization of Electric Energy, The Orient Blackswan Publishers, ISBN: 8125016406 (Chapter: 1,2,3,6)
2.	Mehrdad, Ehsani, Yimin Gao, Sabastien. E. Gay, Ali Emadi	Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Standards media, Edition 2, 2009, ISBN: 9781420053982

Reference books:

1.	J. B. Gupta	Utilization of Electric Power & Electric Traction, S.K. Kataria & Sons, 2013 Edition, ISBN: 9350142589

Course Outcomes: After the completion of this course, students will be able to:

CO1	**Design** heating elements and describe welding processes.
CO2	**Analyse** refining of metals, factors affecting electroplating and speed time curves
CO3	**Analyse** equipment for AC traction systems and interpret braking energy returned to lines.
CO4	**Design** lighting schemes and select proper lamps.
CO5	**Analyse** performance of electric and hybrid vehicles.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)&Program Specific Outcomes

		POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
	CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	1
	CO3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
	CO4	3	3	-	-	-	-	-	-	-	-	-	-	2	-
	CO5	3	3	-	-	-	-	-	-	-	-	-	-	2	1