Course of Study

Choice Based Credit System

B. Tech. (Electrical Engineering)

(Effective from Academic Year 2021-22)

Department of Electrical Engineering,

SGGS Institute of Engineering and Technology, Vishnupuri,

Nanded-431606 (MS), India

(An autonomous institute established by Govt. of Maharashtra)

Program Outcomes (POs)
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.

Program Educational Objectives (PEOs)

Engineering Graduates will be able to:

1. Excel in growing careers involving design, development of electrical / electronic systems by working in the diversified sectors of the industry, government organizations, public sector and multinational corporations and/or pursue higher education at various reputed institutes.
2. Make considerable progress in their chosen domain of interest and will build up additional technical expertise to remain globally competitive.
3. Be able to demonstrate inter-personal skills, professional and personal leadership and growth with commitment to ethical and social responsibilities.

Program Specific Outcomes (PSOs)

1. Specify, design, plan and implement new electrical systems and modification of existing systems in the field of Electrical Engineering.
2. Test, operate, supervise and maintain different Electrical and Electronics equipment’s and integrated systems.
3. Analyze and select appropriate techniques for optimum operation of Power System, Electrical machines, Power electronics and Industrial drives system.

Correlation between the PEOs and the POs

PO/PSO ➡ ⬇ PEO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PEO1	✓	✓				✓	✓						✓		✓
PEO2		✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	
PEO3				✓	✓	✓	✓			✓	✓	✓		✓	✓

Shri Guru Gobind Singhji Institute of Engineering and Technology, Vishnupuri, Nanded

DEPARTMENT OF ELECTRICAL ENGINEERING

Curriculum Structure of B. Tech.

(With effective from 2021-2022)

Semester I						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PCC-EE401	Industrial Drives and Control	03	--	02	03	01
PCC-EE402	Switchgear and Protection	03	--	02	03	01
PCC-EE403	Electrical Machine Design	03	--	02	03	01
HMC-EE404	Industrial Economics and Management	03	--	--	03	--
PEC-EE4**	Elective-III	03	--	02	03	01
PRJ-EE409	Project Work-I	--	--	08	--	04
	Total	**15**	**--**	**16**	**23**	
Semester II (Structure-A)*						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PEC-EE4**	Elective-IV	04	--	--	04	--
PEC-EE4**	Elective-V	03	--	02	03	01
SII-EE418	Seminar on Industrial Training	--	--	02	--	01
PRJ-EE419	Project Work-II (In house)	--	--	16	--	08
	Total	**07**	**--**	**20**	**17**	
Semester II (Structure-B)*						
SII-EE418	Seminar on Industrial Training	--	--	02	--	01
PRJ-EE420	Project Work-II (Industry/Research Institute)	--	--	32	--	16
	Total	**--**	**--**	**34**	**17**	

L – No. of Lecture Hours/week, T – No. of Tutorial Hours/week, P – No. of Practical Hours/week

**A student can opt any one from the Structure A and B of Sem-II. Structure A is for students doing the project in institute and Structure B is for students carrying out project in industry.*

B.Tech.(ELEC)	**Contact Hours**	**Credits**
TOTAL (Structure-A)	58	40
TOTAL (Structure-B)	65	40

Elective-III	
PEC-EE405	High Voltage Engineering
PEC-EE406	PLC and SCADA
PEC-EE407	Artificial Neural Networks and Deep Learning
PEC-EE408	Data Science

Elective-IV		**Elective-V**	
PEC-EE410	HVDC and FACTS	PEC-EE414	Power Quality and Harmonics
PEC-EE411	Power System Restructuring and Deregulation	PEC-EE415	Embedded System Design
PEC-EE412	Smart Electric Grid	PEC-EE416	Advanced Control System
PEC-EE413	Electrical and Hybrid Vehicles	PEC-EE417	Internet of Things (IoT)

- Attendance Criteria: Students have to maintain 75% attendance in all the registered courses in a semester to be eligible for appearing examinations.
- Students are encouraged to take online certification courses and submit it to institute for earning credit. (Coursera, NPTEL, EDX, Udemy, etc)
- If above listed elective courses are available on NPTEL Swayam, students can enrol for the same course and submit passing certificate.

SEMESTER-VII

PCC-EE401 Industrial Drives and Control

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation: 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Electrical Machines, Power electronics & Control System

Course Objective:

1	Provide the basics of DC and AC variable speed drives.
2	Develop awareness for use of variable speed drives for various applications in industry.
3	Develop the ability to repair and maintain the drive panels.
4	Make the student aware of research avenues in the field of Electrical Drives.

Course Outcomes: Students' will be able to:

1	Technical expertise of electrical machines & drives.
2	Apply the knowledge to practical industrial systems
3	Self-learning new technology of electrical drives.
4	Analyse and solve numerical problems on electrical drives.
5	Write technical reports & give presentation on industrial drive systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	-	2	1	-	3	3	2	2	1	3	3	1
2	3	1	1	-	2	2	-	3	3	1	2	1	3	3	1
3	3	2	3	2	3	2	-	3	3	3	3	2	2	2	2
4	2	2	3	3	3	2	-	3	3	3	2	3	2	2	3
5	3	3	3	3	3	2	-	3	3	3	3	3	2	1	3

Syllabus :

Unit 1	**Introduction: (06 Hours)** Advantages of Electrical Drives, Parts of Electrical drive, Choice of Electric drives Dynamics of Electrical drives: fundamental torque equations, multiquadrant operation, nature and classification of load torques, steady state stability, concept of load equalization in drives.
Unit 2	**Control of Electrical Drives: (06 Hours)** Modes of operation: Steady state, Acceleration, Deceleration, Drive classification Closed loop control of drives: Current limit control, torque control, speed control,

	position control and control of multi motor drives, speed sensing, current sensing Classes of motor duty & criteria for selection of motor.
Unit 3	**DC motor drives: (08 Hours)** Review of basic characteristics of DC motors. Single phase drives: Single phase half wave converter drives, semi converter drives, Full converter drives, Dual converter drives. Three phase drives: Three phase half wave drives, semi converter drives, full converter drives, dual converter drives. DC-DC converter drives: Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives. Introduction to closed loop control of DC drives.
Unit 4	**Induction motor drives: (08 Hours)** Review of starting, braking and speed control of three phase induction motors. Induction motor drives: Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control, Current control. Closed loop control of Induction motors. Principle of Scalar and Vector control of Induction motor. Multiquadrant operation of induction motor drives fed from Voltage Source Inverters. Static rotor resistance control method, static slip power recovery control-Static Scherbius drive and Static Kramer drive.
Unit 5	**Synchronous Motor Drives and Brushless DC drives: (06 Hours)** Review of starting, pull in and braking of Synchronous motor, Static variable frequency control for Synchronous motors. Load commutated inverter fed Synchronous motor drive, Introduction to closed loop control of Load commutated inverter fed Synchronous motor drive and Brushless DC drives.
Unit 6	**Drives for Specific Applications: (06 Hours)** Construction and operation of switched reluctance motor, torque equation converter circuits for SRM drives, closed loop motor operation, solar and battery power drive. Textile Mill: various stages and drive requirements control of ac motors for controlling torque. Steel Rolling Mill: reversing and continuous hot and cold rolling mills, Drive requirements, motors for mill drive. Cement mill: Stages in cement production, requirements of mill motors, Kiln drives, crusher drives, fan/blower drives and compressor drive. Sugar Mill: Requirements for various drive motors, selection of motors for various processes.

Text/ Reference Books:

1. Power Electronics by M.H. Rashid, 3rd Ed, PHI Pub. 2004.
2. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publishing house Books.
3. Modern Power Electronics and AC Drives by B. K. Bose, Pearson Education, Asia, 2003.
4. De N. K., Sen P. K., “Electric Drives”, Prentice Hall of India.

Term Work:

At least eight experiments based on the curriculum from the following list should be performed.

1. Speed – torque characteristics of chopper fed D. C. series motor
2. Closed – loop speed control of chopper fed D. C. drive (Simulation)
3. Open loop speed control of single phase full wave, half controlled converter fed D. C. shunt motor

4. Open loop speed control of single phase full wave, full controlled converter fed D. C. shunt motor
5. Closed loop speed control of converter fed D. C. drive
6. Two quadrant single phase converter fed 5 HP DC drive (simulation)
7. Four quadrant single phase converter fed 5 HP DC drive (simulation)
8. Four quadrant chopper fed DC drive (simulation)
9. Speed control of slip – ring induction motor by rotor resistance control
10. Six – step VSI fed induction motor drive, (simulation)
11. Simulation of brushless DC motor drive
12. Speed control of induction motor drive
13. Study of Kramer speed control
14. Speed control of induction motor drive (simulation)

PCC-EE402 Switchgear and Protection

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation :20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:	
1	Power System Engineering
Course Objective:	
1	To Introduce students to power system protection and switchgear
2	To Teach students the protection systems used for electric machines, transformers, bus bars, overhead and underground feeders
3	Develop in students an ability and skill to design the feasible protection systems needed for each main part of a power system
4	Enhance students' knowledge of over- voltage protection and data transmission
Course Outcomes: Students' will be able to:	
1	Knowledgeable in field of power system protection, circuit breakers, protective relaying and instrument transformer
2	Comprehensive study of various relays used in power system protection.
3	Discuss types of circuit breakers with their applications
4	Identify rotor ,stator faults, interterm faults and their protection
5	Design relevant protection system for the power system

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
2	3	1	1	2	2	1		3	1	1	1	1		3	1
3	3	2	3	2		1	1	3	1		1		2	2	2
4		2		3	3		1	3	3	3	1	3	2	2	3
5	3	3	3	3	3	1	1	3	3	3	1	3	2	1	3

Syllabus :

Unit 1	**Fundamentals of Switchgear and Protection: (06 Hours)** Principles of protection and switchgear, different types of switchgear, modes of classification, ratings and specifications. L.T. switchgear: - MCB, MCCB, HRC fuses, type construction and application. Circuit breaker ratings, rewirable and H. R. C. fuses, their characteristics and applications
Unit 2	**Arc Phenomenon and Circuit Breakers: (08 Hours)** Principles of circuit interruption, arc phenomenon, Restricting and recovery voltage. Arc quenching methods. Capacitive, inductive current breaking, resistance switching, Auto reclosing. Circuit Breakers: - Classification of C.B.s – air break, air blast, vacuum, minimum oil and bulk oil, SF6 C.B..
Unit 3	**Protective Relays: (06 Hours)** Protective Relaying: Need of protective relaying in power system, General idea about protective zone, Primary and backup protection, Desirable qualities of protective relaying .Classification of relays, Principle of working and characteristics of attracted armature, balanced beam, induction, disc and cup type relays, induction relays, Setting characteristics of over current; directional, differential, percentage differential and distance (impedance, reactance, mho) relays, introduction to static relays, advantages & disadvantages.
Unit 4	**Transmission System Protection : (08 Hours)** Bus bar: Feeder and Transmission line protection. Busbar protection, Frame leakage protection circulating current protection. Overcurrent relays, philosophy, ORCD.Principles of distance relaying, choice between impedance, reactance and mho types, pilot wire and carrier pilot protection, Zones of protection. Distance relay philosophy and coordination.
Unit 5	**Unit Protection (06 Hours)** Unit protection schemes, protection of transformer, generator.Alternators – Stator fault, stator inter turn protection. Unbalanced load, protection (Negative phase sequence [NPS] protection). Transformer – Use of Buccholz relay, differential protection, connection of C. T. and calculation of C.T.ratio needed for differential relaying, balanced and unbalanced restricted earth fault protection, frame leakage protection.
Unit 6	**Insulation Co-Ordination** : **(06 Hours)** Definitions (Dry flashover voltage FOV), WEF FOV, Impulse FOV, insulation, co-ordinating insulation and protective devices. Basic impulse insulation (BIL), Determination of line insulation. Insulation levels of substation equipment.

	Lightning arrester selection and location. Modern surge diverters and Necessity of power system earthing, Method of earthing the neutral, Peterson coil, earthing of transformer.Overvoltage studies.
Unit 7	**Advancements in Protection: (06 Hours)** Introduction to Wide Area Monitoring System (WAMS) infrastructure. WAMS based protection schemes, Automated fault analysis.

Text/Reference Books:

1. Patara Basu & Chaudhary – Power System Protection. (New Delhi Oxford and IBH).
2. Sunil S. Rao – Switchgear & Protection. (Tata McGraw Hill).
3. A Web Course on 'Digital protection of power system':-Prof. Dr. S.A.Soman, IITBombay.
4. Protection of power systems: - Blackburn.
5. Fundamentals of power system protection: - Y.G.Paithankar, S.R.Bhide. -Prentice hall,India.

Term Work:

Minimum of Eight experiments based on the curriculum from the following list should be performed.

1. Current versus time characteristics of over current relays
2. Study of Electromechanical phase/earth/directional relays
3. Short circuit analysis of a simple power system up to six buses (usingMATLAB/MiPower software)
4. Relay coordination: Over current (using MATLAB/MiPower software)
5. Distance relay coordination (using MiPower/ MATLAB software)
6. Motor protection design (using MiPower/ MATLAB software)
7. Merz-Price protection of transformer.
8. Transmission line protection.
9. Study and use of relay testing kit.
10. Study and testing of moulded case circuit breaker.
11. Study of typical oil circuit breaker.
12. Characteristics of rewirable fuse and H.R.C. fuses.
13. Over voltage studies: line/transformer energization, capacitor switching (using MiPower software)

PCC-EE403 Electrical Machine Design

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation: 20 Marks Mid Semester Exam:30 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Electrical machines

Course Objective:

1	To make students understand the basics of Electrical Machine design.
2	To develop the capabilities in the student to apply basics of Electrical Engineering for design of Electrical machines.
3	To make the student conversant with the design process of Electrical machines and Computer aided design of the Electrical machines.
4	To make students capable of designing Electrical machines with high efficiency.

Course Outcomes: Students' will be able to:

1	Design Distribution and Power transformer with high efficiency.
2	Evaluate performance of transformers related to temperature rise.
3	Understand design of various induction motors.
4	Analyse the performance of Induction motor and Synchronous motor.
5	Apply Computer software for design of various Electrical Machines.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1		3	1
2	3	1	1		2	1	1		1	1	1	1	3	3	1
.3	3	2		2	3		1	3	1	3	1	2		2	2
4	2	2	3			1	1	3	3	3	1	3	2	2	3
5	3	3	3	3	3	1	1	3	3	3	1	3	2	1	

Syllabus :

Unit 1	**Constructional Details and Design of Transformers: (08 Hours)** Core and shell types. Distribution and Power transformers, core and core materials, cooling of cores, windings. Transformer oil, conservators and breathers. Output equation, EMF per turn. Ratio of iron loss to copper loss, Relation between core area and weights of iron and copper, optimum designs Core design. Design of windings. Design of insulation overall dimensions
Unit 2	**Performance Evaluation of Transformer**: **(06 Hours)** Resistance of windings. Leakage reactance, mechanical forces. Calculation of no-load current. Equivalent circuit and performance characteristics, Temperature rise, Design of tank and radiators
Unit 3	**Constructional Details and Design of Three Phase Induction Motors: (08 Hours)**

	Constructional details of Stator and Rotor, Output equation. Specific electric and magnetic loadings. Efficiency and power factor, main dimensions, Stator windings. Type of winding and connection. Turns per phase, shape of stator slots. Number of stator slots, Design of stator stampings. Calculation of air gap length. Design of squirrel cage rotor, Rotor bar current. Shape and size of rotor slots. End ring current. Area of end rings, slip. Design of wound rotor. Rotor windings. Use of standard stampings
Unit 4	**Operating Characteristics of Three Phase Induction Motors: (06 Hours)** No load current Magnetizing current, loss component short circuit current. Resistances, leakage reactance. Use of circle diagram to obtain performance figures. Calculation of static torque, maximum torque, maximum output, maximum power factor. Dispersion coefficient. Effect of dispersion coefficient on maximum p.f. and overload capacity
Unit 5	**Design of Synchronous Machines: (06 Hours)** Review of construction of water wheel and turbo alternators. Different parts and materials used for different parts, choice of electric and magnetic loadings, Output equation Determination of diameter and length. Length of air gap and effect of short circuit ratio on machine performance
Unit 6	**Computer Aided Design of Electrical Machines: (06 Hours)** Benefits of computer in machine design, methods of approach, optimization and computer aided design of induction motor and three phase transformer

Text/ Reference Books:

1. "A Course in Electrical Machine Design" - by A. K. Sawhney, Dhanpat Rai and Sons, Delhi.
2. V.N. Mittle and A. Mittle, "Design of Electrical Machines", Standard Publications & Distributors, Delhi, 2002
3. R.K. Agarwal, "Principles of Electrical Machine Design", S.K.Kataria& Sons, Delhi, 2002
4. S.K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 1987.

Term Work:

The term work consists of the design reports along with the drawing sheets of assembly of Machines and the details there of in case of

1. Single phase transformer
2. Three phase transformer
3. Single phase induction motor
4. Three phase induction motor
5. Synchronous machines

• Any two software base calculation of transformer or induction motor design.

A teacher may add or replace any appropriate experiment / design calculation / Sheets to the Experiments list.

HMC-EE404 Industrial Economics and Management

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	--

Prerequisites Courses:

1	NA

Course Objective:

1	Study the management concept, its functions and responsibility.
2	Understand the human resource management in industry.
3	Understand the store and purchase management.
4	Study the management laws

Course Outcomes: Students' will be able to:

1	Understand the management process and structure in the industry so that it will help them to work in a better way
2	Develop an efficient methodology for industrial management
3	Cater the issues related to current industrial amendments

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
2	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
3	3	2	3	2	3	1	1	3	1	3	1	2	2	2	2

Syllabus :

Unit-1	**Management Concepts :** Management its growth, Concepts, Principles & Managerial objectives
Unit-2	**Industrial Ownership & Forms of Organization :** Types : Single, Partnership, J.S.C. Co-operative, Public Sector, Private Sector, Different Organizational Structure, Line Organization, Functional Organization, Line & Staff Organization
Unit-3	**Personnel Management :** Man Power Planning: Aims objectives, Principles of Personal Management, Recruitment, Selection, Interviews, and Techniques, Performance appraisal, Intensives & Motivation, Job Evaluation and merit rating.
Unit-4	**Management Laws & Intensives :** Concept of Contract Act, Offer & acceptance of guarantee and warranty. MRTP & FERA, Current Package Scheme of incentive for new projects.
Unit-5	**Engineering Economic & Import Export Management :** Utility, Want, Wealth, Demand price determination & business cycle, Concepts of

	International Trade, Duties, anti dumping duty, cost involved in exporting a product "MODVAT".
Unit-6	**Purchase Management & Theory "i" in Management :** Concepts of quotation, tenders, inspection & quality control**.** Global Management Practices'MIS' Management information system

Text/ Reference Books:

Textbook:

1. Industrial Engineering and Management-O.P.Khanna

References:

1. .Management for Business and Industry-C.S.George Jr.
2. Principles of management -Knootsand O.Donnell.
3. Business Organization and Management- M.C. Shulka.

Elective-III

PEC-EE405 High Voltage Engineering

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation:20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs / Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Engineering Physics, Basic Electronics and Network Analysis

Course Objective:

1	The course covers the breakdown mechanisms in gaseous, liquid and solid insulation.
2	Methods of generation and measurement of high voltage, impulse voltage and impulse current are also covered
3	This course lays a foundation for higher studies in high voltage engineering.
4	To study the measurement of High Voltages.

Course Outcomes: Students' will be able to:

1	Observe the breakdown mechanism in gaseous, liquid and solid insulations
2	Illustrate the methods of High voltage generation, Impulse voltage and current
3	Describe the methods of Measurement High voltage, Impulse voltage and current.
4	Design various circuits for the measurement of high frequency voltages and currents.
5	Apply the different tests done on insulators, circuit breakers, cables, transformers ,LA etc.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
2		1	1		2	1	1	3	1	1	1	1	3	3	1
3	3		3	2	3	1	1		1		1			2	2
4	2	3		1	2	2	1	1	3	1	1	1	1	3	3
5	3	3	2	3	2	3	1	1	3	1	3	1	2	2	2

Syllabus :

Unit 1	**Breakdown in Gaseous Medium: (06 Hours)** Townsend mechanism of breakdown in gases, streamer (kanal) mechanism of breakdown in gases, derivation of breakdown criterion for Townsend and streamer mechanisms. Paschen's law for breakdown voltage in gases, effect of pressure and gap distance on breakdown voltage
Unit 2	**Breakdown In Liquid and Solid Insulation: (06 Hours)** Comparison of pure and commercial liquids for insulation, breakdown in pure

	liquids, effect of hydrostatic pressure on breakdown strength. Breakdown in commercial liquids - suspended particle theory, cavitation and bubble theory, thermal breakdown, stressed oil volume theory. Types of breakdown mechanisms in solids - intrinsic, electromechanical, treeing and tracking, thermal breakdown, electrochemical, breakdown due to internal discharges. Breakdown in composite dielectrics, applications of solid dielectrics like paper, mica, glass and ceramics
Unit 3	**Generation of High Voltages: (06 Hours)** Generation of high D.C. voltages by rectifiers, voltage doubler and multiplier circuits, electrostatic machines - Van de Graaff generator, electrostatic generator. Generation of high A.C. voltages by cascade transformer set, resonant transformer, Tesla coil for generation of high frequency A.C. voltage
Unit 4	**Generation Of Impulse Voltage and Current: (06 Hours)** Standard impulse wave shape, analysis of model and commercial impulse generation circuits, wave shape control, Marx circuit, tripping and control of impulse generation. Generation of switching surges, generation of impulse current
Unit 5	**Measurement Of High Voltage and Current: (06 Hours)** Peak voltage measurement by Chubb - Fortescue method, spark gaps, sphere gap, uniform field gap, rod gap, electrostatic voltmeter, measurement of high voltage by an ammeter in series with high impedance, use of rectifier and voltage divider. Measurement of high A.C., D.C. and impulse currents by resistive shunts- Hall generator, current transformer with electro-optical signal converter, squirrel-cage shunt, Rogowski coil
Unit 6	**High Voltage Testing and Partial Discharges: (06 Hours)** High voltage testing of-insulators, bushings, circuit breakers, cables, transformers, lightning arrestors and power capacitors. Phenomenon of partial discharges (PD), internal and surface discharges, effects of PD, equivalent circuit of PD phenomenon, measurement of apparent charge. PD detection - straight detection method, wide band and narrow band detection circuits. Bridge detection method, calibration of PD detectors

Text/ Reference Books:

1. 'High Voltage Engineering Fundamentals' by E. Kuffel& W.S. Zaengl, Pergamon Press, 1992
2. 'High Voltage Engineering' by M.S. Naidu & V. Kamaraju, Tata Mc-Graw Hill, 2002
3. 'High Voltage Engineering' by C.L. Wadhwa, New Age, 2007
4. 'High Voltage Engineering' by E. Kuffel& Abdullah

Term Work:

It will consist of a record of at least eight experiment from the following based on the prescribed Syllabus:

1. Simulation study of voltage doubler circuits using PSpice.
2. Simulation study of impulse voltage generation circuits using PSpice.
3. Experimental study of HVAC generation.
4. Verification of Paschen's law.
5. Experimental study of Greinacher voltage doubler.
6. Experimental study of impulse voltage generation.

7. Breakdown test of insulating oil using Oil Test Kit.
8. Break down test of hardboard insulation plate
9. PD measurement for needle-plane electrode system.
10. To observe the corona using horn gap apparatus.
11. Plane to plane test for breakdown of air.
12. Hemisphere to plane test for breakdown of air.
13. Point to plane test for breakdown of air.
14. Study of tesla coil.

PEC-EE 406 PLC and SCADA

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Electrical Machines, Power electronics & Control System

Course Objective:

1	To understand the role of industrial automation for different processes
2	To learn the application of PLC and SCADA based system in process control.
3	Develop the ability to develop and programmed the PLCs for different processes
4	Make the student aware of research avenues in the field of automation.

Course Outcomes: Students' will be able to:

1	Apply the knowledge of automation in machine control.
2	Learn the basics and working principle of PLC.
3	Know the basics of PLC and ladder diagram programming.
4	Design the automation system for fast and value added quality product for economic growth through technological development
5	Design and conduct practical in realistic constrain on motors such that it is applicable in manufacturing, testing and maintenance field.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
2	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
3	3	2	3		3	1	1	3	1	3	1		2	2	2
4	2		1	1	2		1		3	1	1	1	1	3	3
5	3	3	2	3	2	3	1	1	3			1	2	2	2

Syllabus :

Unit 1	**Basics of Automation: (06 Hours)** Introduction and evolution of Automation, Feedback and feed forward systems, Hierarchical levels of automation, introduction to plant automation.
Unit 2	**Programmable Logic Controller (PLC) : (06 Hours)** Necessity and working principle along with block schematic of PLC, Programming languages, basic instruction for programming like bit, Arithmetic file and Mathematical. Demonstration of PLC functioning and development of ladder for sequencing of motors, tank level control, ON-OFF temperature control.
Unit 3	**Components and Systems of PLC : (08 Hours)** PLC Hardware : Processors, The Power Supply and Programming Devices, The Memory System and I/O Interaction, The Discrete input/output System, The Analog input/output System, Logical Sensors, Logical Actuators.
Unit 4	**PLC PROGRAMMING : (08 Hours)** Introduction to Programming Languages, ladder diagram elements, ladder diagram examples, programmable controllers: relay sequencer, programmable controllers, programmable controller operation, programming, advanced features, ladder diagrams and programming for some typical examples of process control using ABB PLC, Timers and Counters
Unit 5	**Industrial PLC- ABB, GE Fanuc and Siemens make PLC: (08 Hours)** Introduction and programming of Allen Bradely make Micrologix1200c and 1100 PLC, siemens make PLC
Unit 6	**Supervisory Control And Data Acquisition(SCADA): (06 Hours)**Introduction to supervisory control and data acquisition (SCADA) as applied to process control systems: Introduction to various SCADA packages, study of RSVIEW32 (AB make package) development of mimics using RSVIEW32 SCADA package, Study of iFix SCADA package, WinCC.
Unit 7	Use of SCADA in Power Systems, Concept of Load dispatch, Role of Energy Management System applications in Power Management, Indian load dispatch structure

Text/ Reference Books:

1. Gary Dunning, “Introduction to Programmable Logic Controllers” Second Edition, Thomson Delmar learning, 2002.
2. C. D. Johnson, “Process Control Instrumentation Technology” Seventh Edition, Pearson Education, New Delhi 2003.
3. B. G. Liptak,”Instrument Engineers Handbook” (Edition) Vol-II and III, Chilton book Company.
4. Technical Manual –Yokogoawa, centum VP.
5. Webb J. W. and Ronald A. Reis “Programmable Controllers: Principles and Applications”, Prentice Hall of India Pvt. Ltd. Fifth Edition, 2005.
6. John R. Hackworth and Frederick D. Hackworth “Programmable Logic Controllers”, Jr. Third India Reprint 2005.
7. Parr A., Newnes, “Programmable Controllers: An Engineer’s Guide”, Butterwoth-Heinmen Ltd. 1993.
8. C. D. Johnson, “Microprocessor based Process Control”, Prentice Hall International Edition.

9. Mini Thomas and John Douglas McDonald "Power System SCADA and Smart Grids" CRC Press

Term Work

Term work shall consist of at least six to eight assignment/tutorials/practical based on above syllabus. Some of the experiments may be from the following list:-

1. Study of AB Micrologix 1200c and 1100 PLC.
2. Development of simple ladder diagrams like AND/OR gate.
3. Developments of ladder diagram for the controlling motor operation.
4. Development of ladder diagram and simulation for the level control system.
5. Development of ladder diagram for bottling plant.
6. Study of software package RSVIEW32 (AB make) for SCADA.
7. Development of mimic diagram for a particular process using SCADA software.
8. Study of Hybrid controller control logix (AB MAKE).
9. Development of programs for control of processes using Hybrid controller.
10. Study of Yokogowa Centum VP.
11. Development of FBD programs on Centum VP for ON/OFF control.
12. Development of FBD programs on Centum VP for simple process control applications.
13. Visit to Load Dispatch Centre at ALDC, Nagpur or SLDC Kalwa, Mumbai

PEC-EE407 Artificial Neural Networks and Deep Learning

Teaching Scheme :		**Examination Scheme:**	
Lectures	4 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	4	Credits(P)	0

Prerequisites Courses:	
1	Linear Algebra, Matrix Calculus, Feedback Control Systems, Digital Signal Processing
Course Objective:	
1	Understanding of basic concepts of Artificial Neural Networks and Architectures.
2	Introduction to different training algorithms.
3	Understanding the applications of ANN
4	Understanding the concept of Deep Learning
Course Outcomes: Students' will be able to:	
1	Understand and explain the basic concepts of Artificial Neural Networks.
2	Analyse different ANN architectures.
3	Understand and analyse the different training algorithms.
4	Design and develop ANN applications in real world pattern recognition problems.
5	Understand about Deep Learning Concepts.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	1	1	2	2	1	1	3	1	1	1	1	3	3	1
2	3	1	1	2	2	1	1		1	1	1	1	3	3	1
3	3	2	3	2		1	1	3	1		1	2	2	2	2
4	2	3		1	2	2	1	1	3	1	1	1	1	3	3
5	3	3	2		2		1	1	3	1	3	1		2	2

Syllabus :

Unit 1	**Introduction to Neural Networks: (06 Hours)** Historical perspective, the biological inspiration, Neuron Model, Network architecture, Perceptron architecture, Hamming Network, Linear Vector Spaces, Linear Dependence, Inner Product, Norm, Orthogonality
Unit 2	**Linear Transformations and Performance Surface Optimization for Neural Networks: (08 Hours)** Linear Transformations, Matrix Representations, Change of Basis, Eigenvalues and Eigenvectors, Performance Surfaces and Optimum Points, Taylor Series, Directional Derivatives, Minima, Necessary Conditions for Optimality, Quadratic Functions, Performance Optimization, Steepest Descent, Newton’s Method, Conjugate Gradient
Unit 3	**Windrow-Hoff and Backpropagation: (07 Hours)** Windrow-Hoff, ADALINE Network, MSE, LMS algorithm, Multilayer Perceptron, Pattern Classification, Back propagation algorithm. Performance Index, Chain Rule, Batch vs. Incremental Training, Convergence
Unit 4	**Variations on Backpropagation and Generalization: (07 Hours)** Drawbacks, Heuristic Modifications, Numerical Optimization Techniques, Generalization, Methods for improving Generalization: Estimation of Error, Early stopping, Regularization, Bayesian Analysis, Relationship between early stopping and regularization
Unit 5	**Associative Learning, Competitive Networks and Radial Basis Networks: (06 Hours)** Associative Learning, Unsupervised Hebb Rule, Simple Recognition Network, Instar Rule, Simple Recall Network, Outstar Rule, Competitive Networks, Hamming Network, Competitive Layer, Competitive rule in biology Self-organizing Feature Maps, Learning Vector Quantization, Radial Basis Function Networks, Training RBFN
Unit 6	**Understanding of Deep Learning: (06 Hours)** Restricted Boltzmann machine, Auto-encoder, Convolutional Neural Networks.

Text /Reference Books:

1. Martin T. Hagan, Howard B. Demuth, Mark Hudson Beale, Orlando De Jesus, “Neural Network Design”, 2nd Edtion.

2. Hinton, Geoffrey. "A practical guide to training restricted Boltzmann machines." Momentum 9.1 (2010): 926.Volume 7700 of the series Lecture Notes in Computer Science pp 599-619.
3. Le, Quoc V. "A Tutorial on Deep Learning Part 1: Nonlinear Classifiers and The Backpropagation Algorithm." (2015).
4. Le, Quoc V. "A Tutorial on Deep Learning Part 2: Autoencoders, Convolutional Neural Networks and Recurrent Neural Networks." (2015).
5. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, PearsonEducation.
6. Simon Haykin, "Neural Network and Learning Machines", 3rd Edition, Pearson Education.
7. Jacek Zurada, "Introduction to Artificial Neural Network", Jaico Publishing House India

WEBSITES FOR REFERENCE

https://nptel.ac.in/courses/106105077
https://nptel.ac.in/courses/106106126
https://aima.cs.berkeley.edu

PEC-EE 408 Data Science

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Introduction to Programming , Probability

Course Objective:

1	The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Course Outcomes: Students' will be able to:

1	Demonstrate understanding of the mathematical foundations needed for data science.
2	Collect, explore, clean, mange and manipulate data.
3	Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering
3	Build data science applications using Python based toolkits.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1	3	1	3	1	2	2	2	2
2		3		1	2	2		1	3	1	1		1	3	3
3	3	3	2		2	3	1	1		1		1	2	2	2

Syllabus :

Unit 1	**Introduction to Data Science : (06 Hours)** Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.
Unit 2	**Introduction to Programming Tools for Data Science: (10 Hours)** Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK Visualizing Data: Bar Charts, Line Charts, Scatter plots Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Managing, Manipulating Data, Rescaling, Dimensionality Reduction
Unit 3	**Mathematical Foundations: (18 Hours)** Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem,

	Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P- hacking, Bayesian Inference
Unit 4	**Machine Learning: (8 Hours)** Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks- Learning And Generalization, Overview of Deep Learning.
Unit 5	**Case Studies of Data Science Application:** Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

LIST OF PRACTICALS

1. Write a programme in Python to predict the class of the flower based on available attributes.
2. Write a programme in Python to predict if a loan will get approved or not.
3. Write a programme in Python to predict the traffic on a new mode of transport.
4. Write a programme in Python to predict the class of user.
5. Write a programme in Python to identify the tweets which are hate tweets and which are not.
6. Write a programme in Python to predict the age of the actors.
7. Mini project to predict the time taken to solve a problem given the current status of the user.

LIST OF SUGGESTED BOOKS

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., “Data Sciences”, Khanna Publishing House, Delhi.
4. Jain V.K., “Big Data and Hadoop”, Khanna Publishing House, Delhi.
5. Jeeva Jose, “Machine Learning”, Khanna Publishing House, Delhi.
6. Chopra Rajiv, “Machine Learning”, Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning",

		MIT Press http://www.deeplearningbook.org
	8.	Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

PRJ-EE409 : Project Work-I

Teaching Scheme :		**Examination Scheme:**	
Lectures	--	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam :30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	8 Hrs / Week		
Credits (Th)	--	Credits(P)	4

The objective of Project Work-I is to enable the student to take up investigative study in the broad field of Electrical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor Industry experts . This is expected to provide a good initiation for the student(s) in R&D work and this work will be base for Project work-II and dissertation in last semester of their B.Tech degree.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
4. Preparing a Written Report on the Study conducted for presentation to the Department;

Final Seminar, as oral Presentation before a departmental committee.

SEMESTER- VIII (STRUCTURE A)

Elective-IV

PEC-EE410 HVDC and FACTS			
Teaching Scheme :		**Examination Scheme:**	
Lectures	4 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	4	Credits(P)	--

Prerequisites Courses:

1	Power Systems, Power Electronics

Course Objective:

1	To analyse the operation of shunt and series compensators
2	To impart knowledge on FACTS controllers to improve AC Transmission Capability and Stability
3	To understand the configuration and working of HVDC & EHVAC systems
4	To analyze harmonics and to understand the different protection schemes and Harmonic filters for HVDC System

Course Outcomes: At the end of the course students' will be able to:

1	Understand the power system operation and management.
2	Differentiate between EHVAC and HVDC systems and their suitability in case of power system installation.
3	Understand the technical and economic considerations of both EHVAC and HVDC systems.
4	Analyse various methods for Harmonic elimination.
5	Design various Reactive Power compensation schemes for AC systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1	3	1	3	1	2	2	2	2
2	2	3	1	1	2	2	1	1	3	1	1	1	1	3	3
3			2	3		3	1				3	1	2	2	2
4	3	2	3	2		1	1	3	1	3	1	2	2	2	2
5		3	1	1	2			1	3		1	1	1	3	3

Syllabus :

Unit 1	**Introduction: (08 Hours)** General Aspects HVDC Transmission: Constitution of EHVAC and DC links, Types of HVDC links, HVDC projects in India and abroad, limitations and advantages of HVDC transmission over EHVAC, Layout of HVDC station.
Unit 2	**Grid control and Protection: (10 Hours)** Grid control of thyristor valve, Basic means of control, Power reversal, Common Ignition Angle and Common Extinction Angle control, Constant Current control;

	Protection: Mis-operation of converters short circuit on a rectifier, commutation failure, causes and remedies, Protection of HVDC system, d. c. rectors, damper circuits, Over current protection and overvoltage protection.
Unit 3	**Reactive power compensation: (06 Hours)** Concept of reactive power compensation reactive Power balance in HVDC substations, Effect of angle of advance and extinction angle on reactive power requirement of converters.
Unit 4	**Harmonics and Filters and MTDC systems (08 Hours)** Characteristic and uncharacteristic harmonics causes, consequences and suppression troubles caused by harmonics, Definitions used in Harmonic distortion calculations, Harmonic filters: Types, Location, Criteria for adequacy, MTDC systems: Introduction, Potential Applications of MTDC Systems, Types of MTDC Systems, Control and Protection of MTDC Systems
Unit 5	**General considerations of FACTS (08 Hours)** FACTS Concept and General system Considerations, Limits of line loading capability(St. Clair curve of EHVAC Line loading), Power Flow and Dynamic Stability considerations of a transmission interconnection, Significance of controllable parameters, Comparison between HVDC and EHVAC(FACTS)
Unit 6	**Shunt, series and combined FACTS controllers: (08 Hours)** Shunt Controllers: Operation ofSVC and STATCOM, Operation of TSC, TCR, STATCOM - Comparison between SVC and STATCOM,Series Controllers: GCSC, TSSC, TCSC and SSSC operation and control, Sub-synchronous Resonance (SSR) and its damping, Combined series-shunt controllers: UPFC and IPFC

Text/ Reference Books:

1. ”HVDC Power Transmission System” K.R. Padiyar , Wiley Eastern Ltd., New Delhi.
2. “EHVAC and HVDC Transmission” - S. Rao, Khanna Pub. Delhi.
3. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 2000 by N.G. Hingorani & L. Gyugyi

PEC-EE 411 Power System Restructuring and Deregulation

Teaching Scheme :		**Examination Scheme:**	
Lectures	4 Hrs/ Week	Theory: In Semester Evaluation :20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	4	Credits(P)	--

Prerequisites Courses:

1	Power System Engineering, Power System Analysis and Stability

Course Objective:

1	To educate about the process of restructuring of Power System
2	To analyse the concept of location marginal pricing and transmission rights
3	To illustrate in-depth understanding of operation of deregulated electricity market system
4	To gain knowledge of fundamental concept of congestion management

Course Outcomes: Students' will be able to:

1	Describe the process of restructuring of power system
2	Identify various operation of restructured power system
3	Analyse pricing and transmission rights of Electricity.
4	Analyse various cost components in Generation, transmission, distribution sector and tariff

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1	3	1	3	1		2	2	2
2	2	3	1	1	2	2	1	1	3	1			1	3	3
3	3	3		3	2	3	1		3	1	3		2	2	2
4	3	2	3	2		1		3	1	3	1		2	2	2

Syllabus :

Unit 1	**Power Scenario in India : (06 Hrs)** Institutional structure before reforms. Roles of various key entities in India. Necessity of Deregulation or Restructuring. RC Act 1998 and Electricity Act 2003 and its implications for Restructuring & Deregulation. Institutional structure during reform. National Energy policy. Introduction to Energy Exchange and trading of Renewable Energy Credits and Carbon Credits.
Unit 2	**Economics of Power Sector: (06 Hrs)** Introduction to various concepts such as capital cost, debt and equity, depreciation, fixed and variable costs, working capital, profitability indices etc. Typical cost components of utilities such as return in equity, depreciation, interest and finance charges, O and M expenses etc. Key Indices for assessment of utility performances. Principles of Tariff setting, Phases of Tariff determination, consumer tariff & non-price issues.
Unit 3	**Power Sector Regulation : (04 Hrs)**

	Regulatory process in India, types and methods of Regulation, cost plus, performance-basedregulation, price cap, revenue cap regulation, rate of return regulation, benchmarking or yardstick regulation. Role of regulatory commission. Considerations of socio economic aspects in regulation.
Unit 4	**Introduction to Power Sector Restructuring : (06 Hrs)** Introduction, models based on energy trading or structural models – monopoly, single buyer, wholesale competition, retail competition. Models based on contractual arrangements – pool model, bilateral dispatch, pool and bilateral trades, multilateral trades, ownership models, ISO models. Competition for the market vs competition in the market, International experience With electricity reform – Latin America, Nordic Pool, UK, USA, China and India. California Energy Crisis.
Unit 5	**Electricity Markets: (06 Hrs)** Trading – electricity market places, rules that govern electricity markets, peculiarity of electricity as a commodity, various models of trading arrangements – integrated tradingmodel, wheeling trading model, decentralized trading model. Various electricity markets such as spot, day ahead, forward, future options, reserve, and ancillary services market. Market operation, settlement process, Market Clearing Price (MCP), Market power, market efficiency. Spot, dynamic and locational pricing. Overview of Electricity Market structure in India, power trending exchanges (Ref : NLDC website)
Unit 6	**Transmission Pricing & Transmission Congestion Issues: (06 Hrs)** Cost components of transmission system, Transmission pricing methods. Cost of transmission services, physical transmission rights. Pricing and related issues. Congestion in power network, reasons for congestion, classification of congestion management, useful definitions. Methods of congestion management, Locational marginal Pricing (LMR), Firm Transmission Right (FTR). Availability based Tariff (ABT) in India.

Text/ Reference Books:

1. Lei Lee Lai, " Power System Restructuring and Deregulation" John Wiley and Sons UK, 2001
2. "Know Your Power:, A citizen Primer on the electricity Sector, Prayas Energy Group, Pune
3. Mohammad Shahidehpour, Hatim Yamin, Zuyi Li, "Market operations in Electric Power System" A John Wiley & Sons Publications
4. Kankar Bhattacharya, Math Bollen, Jaap E. Daalder, "Operation of Restructured Power Systems"Springer US, 2012
5. H. Lee Willis, Lorrin Philipson, "Understanding Electric Utilities and De-regulation" CRC Press, 31-Oct-2014.

Websites:

1. Indian energy exchange: http://www.iexindia.com/
2. Indian power India limited: http://www.powerexindia.com/
3. Indian Electricity Regulations: http://www.cercind.gov.in/

PEC-EE412 Smart Electric Grid

Teaching Scheme :		Examination Scheme:	
Lectures	4 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Term:30 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	4	Credits(P)	--

Course Objective:

1	To provide an understanding of why Smart Grids are critical to the Sustainability and growth of India's electricity network.
2	To enable a shift from today's situation to the intelligent, profitable, efficient, reliable
3	To enable consumer orientated grid required to meet the challenges of the future with minimum impact to the environment.

Course Outcomes: Students' will be able to:

1	Understand what is the concept of Smart Grid
2	Understand working of main components involved in Smart Electric Grid
3	Analyse how electricity problem can be solved by Smart Electric Grid technology
4	Observe and find solution on power quality issues on Smart Electric Grid
5	Know about importance of communication technology in smart Electric Grid

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1			3	1	2	2	2	2
2	2	3	1	1	2	2	1	1	3	1		1	1	3	3
3	3	3	2	3	2	3	1	1	3	1		1	2	2	2
4	3	2		2				3	1	3	1		2	2	2
5	2	3	1	1			1	1		1	1		1	3	3

Syllabus :

Unit 1	**Introduction: (06 Hours)** What is driving the move towards Smart Grids globally and in India? What is a Smart Grid? Overview of how Indian power market is organized, operated and challenges being faced, Overview of how the Indian GENERATION, TRANSMISSION and DISTRIBUTION businessis operated and controlled and some of the challenges being faced. Role of Wind and Solar generation in power system operations, Importance of Load Management
Unit 2	**Smart Grid Technologies: (10 Hours)** Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic MeterReading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV),Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers. Smart Substations, Substation Automation, Feeder Automation. Geographic InformationSystem(GIS), Intelligent

	Electronic Devices(IED) & their application for monitoring &protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage,Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).
Unit 3	**Electrifying rural India through Smart grid: (06 Hours)** Electrifying India's rural community and the challenges being faced.(Developing technology andsystems that will enable smarter rural electrification, Financing programmes, Virtual powerplants, Solar power, Geothermic power), Smart Utilities (case studies), Presentation on the Smart Grid Maturity Model (SGMM), Architecture for smart grids.
Unit 4	**Power Quality Issues in Smart Grid: (06 Hours)** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected RenewableEnergy Sources, Power Quality Conditioners for Smart Grid, Web based Power Qualitymonitoring, Power Quality Audit.
Unit 5	**Information and Communication Technology for Smart Grid: (06 Hours)** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood AreaNetwork (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max basedcommunication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Text/ Reference Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and RenewableEnergy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
6. A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2010.
7. Grid wise Alliance website http://www.gridwise.org/

PEC-EE413 Electric and Hybrid Vehicles

Teaching Scheme :		**Examination Scheme:**	
Lectures	4 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	4	Credits(P)	

Prerequisites Courses:

1	Electrical Drives, Electrical Machines

Course Objective:

1	To impart knowledge of emerging technology in the domain of electric and hybrid vehicle

Course Outcomes: Students' will be able to:

1	Understand the models to describe hybrid vehicles and their performance.
2	Understand the different possible ways of energy storage.
3	Understand the different strategies related to energy storage systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1	3	1	3	1	2	2	2	2
2	2	3	1		2	2		1	3		1	1	1	3	3
3	1	3	2	3	2	3	1	1	3		3	1	2	2	2

Syllabus :

Unit 1	**Introduction: (06 Hours)** Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles,\ social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive- train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. .
Unit 2	**Electric Trains: (10 Hours)** Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

Unit 3	**Energy Storage: (18 Hours)** Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems
Unit 4	**Energy Management Strategies: (8 Hours)** Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

LIST OF SUGGESTED BOOKS

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

Elective-V

PEC-EE414 Power Quality and Harmonics

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation :20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/ Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Power Electronics, Power System

Course Objective:

1	Understand electrical power quality problems.
2	Understand voltage sag and swell problem.
3	Understand harmonic problem in system.
4	Overcome harmonics in system by designing harmonic filters.
5	Make aware about power quality measuring instruments /devices.

Course Outcomes: Students' will be able to:

1	Understand definitions of power quality, power quality standards.
2	Distinguish between voltage sag and swell.
3	Identify power quality disturbances & classify power quality problems.
4	Understand the methods to mitigate harmonics in system.
5	Design Active and Passive filters.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2		2	3	1	1	3	1	3	1	2	2	2	2
2	2	3	1	1	2	2	1	1		1	1	1	1	3	3
3	1	3	2		2	1	1	1	1	1	2	1	2	2	2
4	1	2		2		1	1	3	1	3	1	2	2	2	2
5	2	3	1	1				1		1		1	1	3	3

Syllabus :

Unit 1	**Power Quality-Introduction:(06 Hours)** Introduction, Electromagnetic phenomena–Transients, Long and short duration voltage variations, wave form distortion.
Unit 2	**Voltage Sag and Interruptions: (06 Hours)** End user issues: Ferro resonant Transformers, UPS systems Voltage Tolerance envelops of CBEMA & ITIC, Reliability Indices.
Unit 3	**Power Quality Monitoring: (06 Hours)** PQ measurement equipment and their use, wiring and grounding: Typical wiring and grounding problems, solutions with proper grounding practices and use of signal reference grid.

Unit 4	**Fundamentals of Harmonics: (06 Hours)** Representation characteristic harmonics, Harmonic indices Harmonic sources-6&12 pulse related harmonics, harmonic effects on power apparatus and on measurements, interference with communications.
Unit 5	**Harmonic Elimination: (06 Hours)** Shunt passive filters, types, Design considerations and illustrative examples, Active filters: types, current and voltage source active filters, shunt, series & Hybrid active filters.
Unit 6	**Harmonic Measurements: (06 Hours)** Analysis and Digital methods, presentation of Harmonic data, Response and standards for their limitation.

Text/ Reference Books:

1. "Electrical Power Systems Quality" by Roger C. Dugan, Mark F. Mc Granton & H. Wayne Beety – McGraw Hill.
2." Power System harmonics" by J. Arillaga, DA Bradley & PS Bodger – John Wiley Sons
3. "Power System Harmonics - Fundamentals, Analysis & filter Design" by George J. Wakileh – Springel.
4. "Uninterruptible Power Supplies and Active Filters" by Ali Emadi, Abdolhorein Nasiri & Stoyon B. Bekiarov, CRC Press.
5. "Electric Power Distribution Reliability" 2nd Edition Richard E. Brown, CRC Press.

Term Work:

At least six experiments based on the curriculum from the following list should be performed.

1. Study of Electrical power quality as per IEEE /IEC standard.
2. Interpret IEEE /IEC standard for recommended practices and requirements for Harmonic control in electrical power systems.
3. Simulation of voltage sag and swell by using MATLAB SIMULINK.
4. Analyze the performance of a three phase(star and delta) balanced and unbalanced system supplying R-L loadsby plotting phase currents, real, reactive and apparent power and power factor.
5. Measurement of harmonics using power Analyzer.
6. Study of different type of filters for harmonic elimination (using MiPower).
7. Analyze the harmonic spectrum of a single phase system with sinusoidal voltage source supplying a non-linear (rectifier) load.

Practical Examination:

The examination will be of three hours duration and will consist of an experiment based on term work and followed by an oral based on above syllabus.

PEC-EE 415 Embedded System Design

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester evaluation: 20 Marks Mid Term:30 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/ Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Digital Electronics, Microprocessors, Microcontrollers, C programming

Course Objective:

1	Study of RISC architecture.
2	Understanding and usage of ARM development tools.
3	Understanding linux kernel and device driver programming.
4	Study, design and develop various embedded applications using ARM processor.

Course Outcomes: Students will be able to:

1	Understanding of RISC architecture of processor, its features and applications.
2	Hands on usage of IDE of processors and algorithm development.
3	To understand concept of OS, RTOS and application perspectives.
4	Study, design, analyze and prototype various embedded systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO12	PSO1	PSO2	PSO 3
1	1	2	3	2	3	1	1	3	1	3	1	2	2	2	2
2	2	3	1	1	1	2	1	1	3	1	1	1	1	3	3
3		3	2		2	1		1	1	1	3	1	2	2	2
4	2	2	3	2	1	1	1	3	1		1	2	2	2	2

Syllabus :

Unit 1	**Introduction to Embedded Systems: (08 Hours)** Embedded system definition, different scales of embedded systems, design with small scale embedded systems, CISC and RISC architecture, 32 bit Microcontrollers: Internal Block Diagram, CPU, ALU, address bus, data bus, control signals, Working Registers, SFRs, Clock and Reset circuits, Stack and use of Stack Pointer, Program Counter. I/O Ports, Memory structure, Data Memory, Program Memory , Architecture, Instruction set, different addressing modes, I/O ports, TIMER2 and interrupts, UART, External Interrupts and Timers.
Unit 2	**ARM processor: (06 Hours)** Architecture, Processor modes, Register organization, Exceptions and its handling, Memory and memory management, ARM and THUMB instruction sets, addressing modes, ARM floating point architecture. Real-Time system (RTOS) concepts, Kernel structure, Task management, Inter task communication &synchronization, Understanding Device Drivers.
Unit 3	**Assembly language programming and hardware interfacing techniques:**

	(06 Hours) Introduction to development tools like cross assembler, simulator, HLL cross compilers and in circuit emulators for system development. On-chip interfaces: Digital I/O pins, ADC, DAC, timers, counters, PWM, watchdog timers, LCD, LEDs, seven segment displays, I2C E2 PROM and their applications. External Interfaces: Stepper motor interfacing, DC Motor interfacing, sensor interfacing, SPI, CAN Protocols, USB protocol, Blue-tooth protocol. Writing application level programs for these interfaces using High level languages.
Unit 4	**Introduction to Real-Time /Embedded Operating Systems: (06 Hours)** Real Time Scheduling, Inter process communication, Programming paradigms: FSM and concurrent process models, Performance Metrics of RTOS, Linux &Linux Internals, Programming in Linux &Linux, Configuring & Compiling Linux, Overview of other RTOS.
Unit 5	**Advanced Embedded programming: (08 Hours)** Advanced C programming, Function calls, passing / returning values, Advance Pointers and Arrays, Hashing and Bitwise operation, Dynamic memory allocation, Introduction to OS services, Process, memory & I/O management, Socket and Thread programming, Data structure, Creating a linked list, linked stack and queue, double and circular linked list, sparse matrices, binary tree, Interrupt handling in C, Code optimization issues in Embedded C.
Unit 6	**Introduction to Raspberry Pi: (06 Hours)** Operational Basics, Hardware Dependencies for running OS n minimalist Setup, Getting started with Linux Shell scripting, Basics of kernel based hardware control, Device control from shell terminal, Remote access to device.

Text /Reference Books:

1. Frank Vahid and Tony Givargis, Embedded system design: A unified hardware/software introduction, John Wiley and sons, 2002
2. Raj Kamal, “Embedded Systems” TATA McGraw Hill Edition.
3. Sloss Andrew N, Symes Dominic, Wright Chris; ARM System Developer's Guide: Designing and Optimizing; Morgan Kaufman Publication.
4. An Implementation guide to Real Time Programming - David L. Ripps, Yourdon Press, 1990.
5. D. E. Simon, An embedded software primer, Pearson Education, 2002
6. D. W. Lewis, Fundamentals of embedded software, Pearson Education
7. J. W. S. Liu, Real time systems, Pearson Education
8. Silberchatz, Galvin, Gagne, Operating system concepts, John Wiley
9. Dr. K. V. K. K. Prasad, “Embedded / Real – Time Systems: Concept, Design & Programming”, Dreamtech Press.
10. Technical references on www.arm.com

Term Work:

The term work shall consist of Embedded “C” programming for ARM processor using Keil Cross Compiler or SCARM compiler. Minimum 8 of the following Interfacings of following with LPC2148 are required along with some experiments on Raspberry Pi.

1. Digital input output.
2. Flashing LEDs.
3. 7-segment display.
4. LCD display.
5. Use of ADC for voltage measurement.
6. Waveform generation using DAC.
7. Sensor interfacing.
8. RTC interfacing.
9. E2PROM interfacing.
10. Stepper motor
11. DC Motor

PEC-EE 416 Advanced Control System

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Feedback Control System, Control system design

Course Objective:

1	Apply advance control techniques to electrical systems
2	Explain Control system design by frequency response.
3	Explain design of nonlinear control system using describing function concepts and phase plane techniques.
4	Design optimal controller, Intelligent Controllers
5	To know basic mathematical modelling of system

Course Outcomes: Students' will be able to:

1	Understand the concepts of nonlinear control system
2	Understand the concepts of advance control theory using state-feedback approach
3	Compare and analyze the classical control system with advance control system.
3	Develop advanced controllers to the existing system using advanced control design techniques.
4	Formulate optimal control problem.
5	Understand process control system.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1		1		1	2	2	2	2
2	2	1	1		2	2	1	1	2	1		1	1	3	3
.3	1	3	2	3		1	1	3	2	1		1	2	2	2
4	1	1		2	3	1	1	1	1	3		2	2	2	2
5	2	3	1	1		2	1	1	3			1	1	3	3

Syllabus :

Unit 1	**Non-linear Control system: (06 Hours)** Introduction to non-linear systems, Describing function analysis, phase plane analysis, bang bang control system, Lyapunovs stability analysis.
Unit 2	**State feedback control system:: (06 Hours)** Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, physical systems and state assignment concept of controllability & observability, State feedback by pole placement, observers, Lag and Lead compensator design.
Unit 3	**Robust control system: (06 Hours)** Robust control systems and system sensitivity, Analysis of robustness, system

	with uncertain parameters, design of robust control system.
Unit 4	**Optimal Control System: (06 Hours)** Introduction to optimal control system, problems, Quadratic performance index, Introduction to Adaptive control
Unit 5	**Process control system: (06 Hours)** Introduction to process control, various control configuration such as: feedforward, cascaded etc. PID controller and implementation..
Unit 6	**System Modelling (06 Hours)** Introduction, types of modelling, modelling of time-varying, distributed, stochastic, nonlinear, discrete event and hybrid systems.

Text/ Reference Books:

1. S. Sastry and M. Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 1989.
2. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
3. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
4. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
5. Nagrath& Gopal, "Modern Control Engineering", New Age International.

Term Work:

At least six experiments based on the curriculum from the following list should be performed.

1. to design and study the effect of different Compensation for given system using MATLAB
2. to design and study the effect of different Compensation for given system using experimental kit
3. MATLAB program for state space analysis to transfer function, transfer function to state space analysis, controllability, observability, diagonalization of the system
4. Study of magnetic levitation using kit
5. To study transfer function of any one physical system
6. To study describing function analysis using MATLAB
7. To study 2nd order pole placement controller using MATLB
8. Experimentally evaluate the closed loop performance of the control setup for different P and PI controller settings and compare with simulation results.

PEC-EE 417 Internet of Things (IoT)

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:

1	Sensors, System Integration, Cloud and Network Security

Course Objective:

1	The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Course Outcomes: Students' will be able to:

1	Understand internet of Things and its hardware and software components
2	Interface I/O devices, sensors & communication modules
3	Remotely monitor data and control devices
3	Develop real life IoT based projects

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	3	2	3	2	3	1	1	3	1	3	1	2	2	2	2
2	2	3	1	1	1	2	1	1	3	1	1	1	1	3	3
3	3	3	2	1	2	1	1	1	3	1	1	1	2	2	2

Syllabus :

Unit 1	**Introduction to IoT : (06 Hours)** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT. .
Unit 2	**Elements of IoT: (10 Hours)** Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP
Unit 3	**IoT Application Development: (18 Hours)** Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices
Unit 4	**IoT Case Studies : (8 Hours)** IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

LIST OF PRACTICALS

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

LIST OF SUGGESTED BOOKS

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press

4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

SII-EE 418: Seminar on Industrial Training

Teaching Scheme :		**Examination Scheme:**	
Lectures	--	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs / Week		
Credits (Th)	--	Credits(P)	1

Minimum of six weeks in an Industry in the area of Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report

PRJ-EE419 : Project Work-II and Dissertation (In house)

Teaching Scheme :		**Examination Scheme:**	
Lectures	--	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam :30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	16 Hrs / Week		
Credits (Th)	--	Credits(P)	8

The object of Project Work-II & Dissertation is to enable the student to extend further the investigative study taken up under project work-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under project work-I
2. Review and finalization of the Approach to the Problem relating to the assigned topic
3. Preparing an Action Plan for conducting the investigation, including team work
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
5. Final development of product/process, testing, results, conclusions and future directions
6. Preparing a paper for Conference presentation/Publication in Journals, if possible
7. Preparing a Dissertation in the standard format for being evaluated by the Department.

Final Seminar Presentation before a Departmental Committee

SEMESTER VIII (STRUCTURE B)

SII-EE418: Seminar on Industrial Training			
Teaching Scheme :		**Examination Scheme:**	
Lectures	--	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs / Week		
Credits (Th)	--	Credits(P)	1
Minimum of six weeks in an Industry in the area of Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.			

PRJ-EE420: Project Work-II (Industry/Research Institute)			
		Examination Scheme:	
Lectures	--	Theory: In Semester Evaluation : 20 Marks Mid Semester Exam:30 Marks End Semester Exam :50 Marks	
Tutorials	--		
Practical	32 Hrs / Week		
Credits (Th)	--	Credits(P)	16

The object of Project Work-II & Dissertation is to enable the student to extend further the investigative study taken up under project work-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under project work-I
2. Review and finalization of the Approach to the Problem relating to the assigned topic
3. Preparing an Action Plan for conducting the investigation, including team work
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
5. Final development of product/process, testing, results, conclusions and future directions
6. Preparing a paper for Conference presentation/Publication in Journals, if possible
7. Preparing a Dissertation in the standard format for being evaluated by the Department. Final Seminar Presentation before a Departmental Committee