Teaching and Evaluation Scheme for T Y B. Tech.

Department of Electrical Engineering

Semester: V

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COLLEGE OF ENGINEERING
Yadrav (Ichalkaranji) Dist.Kolhapur

Department: Electrical Engineering

Rev: Course Structure/00/2021-22

Class: T.Y. B.Tech.

Semester: V

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
EE501	PCC	Power Electronics	3	-	-	3	10	10	30	50	100	3
EE502	PCC	AC Machines	4	-	-	4	10	10	30	50	100	4
EE503	PCC	Microprocessor & Microcontroller	3	-	-	3	10	10	30	50	100	3
EE504	PEC	Elective- II	3	-	-	3	10	10	30	50	100	3
OEC01	OEC	Open Elective-I	3	-	-	3	10	10	30	50	100	3
EE505	PCC	Power Electronics Laboratory	-	-	2	2	15	15	-	20	50	1
EE506	PCC	AC Machines Laboratory	-	-	2	2	15	15	-	20	50	1
EE507	PCC	Microprocessor & Microcontroller Laboratory	-	-	2	2	15	15	-	20	50	1
HMS05	HSMC	Aptitude Skills-III	1	-	-	1	25	25	-	-	50	1
HMS06	HSMC	Language Skills-III	-	-	2	2	25	25	-	-	50	Audit
PRJ04	PROJ	Mini Project - IV	-	-	2	2	25	25	-	-	50	1
Total			**17**	**-**	**10**	**27**	**170**	**170**	**150**	**310**	**800**	21

Elective –II:

A. Industrial Automation, PLC and SCADA
B. Python Programming
C. Power System Operation and Control
D. Energy Audit and Conservation

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Power Electronics

EE501	PCC	Power Electronics	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Electronics Engineering, Analog and Digital Electronics

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

CO1	To explain characteristics of different power electronic switching devices
CO2	To explain working principle of rectifiers for different types of loads
CO3	To explain working principle of choppers
CO4	To explain working principle of voltage source and current source inverters in different modes
CO5	To explain working principle of AC voltage controllers
CO6	To explain working principle of cycloconverters

Course Contents:

Unit 1: Power Semiconductor Devices Types of power converters, Power semiconductor switches and their V-I characteristics-diodes, SCR, TRIAC, DIAC, BJT, power MOSFET, IGBT, Thyristor ratings and protection, Firing circuits for Thyristors, Methods of SCR commutation, Manufacturers of Semiconductor devices	[7]
Unit 2: Phase Controlled Rectifiers Principles of single-phase fully-controlled converter with R, RL, and RLE load, Principles of single-phase half-controlled converter with RL and RLE load, Principles of three-phase fully controlled converter operation with RLE load, Effect of source impedances on	[9]

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performance of convertors, Numerical based on output voltage and current calculations, Dual converters	
Unit 3: Choppers Basic principles of step-down and step-up operation, Chopper classification, Control techniques, Study of Buck, Boost and Buck-Boost regulators, Fly back converters, Numerical on step-down and step-up chopper	[7]
Unit 4: Inverters Principle of operation, Performance parameters, Single phase full bridge VSI, Single phase current source inverter with ideal switches and load commutated CSI, 3-phase VSI - 120 and 180 degrees mode of operation, Voltage control of single phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation, Introduction to Multilevel Converter	[8]
Unit 5: A.C. Voltage Controllers Principle of operation of single phase voltage controllers for R, R-L loads, Derivation of output voltage, Introduction of two stage AC voltage regulator	[6]
Unit 6: Cycloconverters Principle of operation of single phase and three phase cycloconverters, Output voltage equation for cycloconverter, Load commutated cycloconverter	[6]

Text Books:

1. Dr. P. S. Bimbhra, "Power Electronics", Khanna Publishers, Delhi
2. M H Rashid, "Power Electronics – circuits, devices and applications", 3rd edition, Pearson Education.

Reference Books:

1. Power Electronics, M.D. Singh & K.B. Khanchandani, TMH
2. Ned Mohan, T. Undeland & W. Robbins, "Power Electronics Converters applications and design" 2nd edition, John Willey & sons, Singapore
3. P.C. Sen, "Modern Power Electronics", S Chand & Co New Delhi
4. U. R. Moorthi, "Power Electronics, Devices, Circuits & Industrial Applications" , Oxford University Press, New Delhi, 2005

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AC Machines

EE502	PCC	AC Machines	4-0-0	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 4 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Electrical Engineering

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

CO1	Analyze performance of induction motor.
CO2	Design various parts of Three Phase Induction Motor.
CO3	Analyze performance of Three phase alternator.
CO4	Design various parts of Alternators.
CO5	Analyze performance Synchronous Motor
CO6	Design of Electrical Apparatus.

Course Contents:

Unit I: Three phase Induction Motor:- Generation of flux and mmf waves, development of circuit model, Rotor quantities (emf ,current, frequency, pf), torque equation, starting torque, running torque, Factors affecting torque, condition of maximum torque ,torque slip characteristics (numerical on torque equation), power flow diagram with numerical, cogging and crawling, deep bar/ double cage rotor, induction generator	[7]
Unit 2: Design of 3 Phase Induction Motor :- Main Dimension, Shapes of Stator Slots, No. of Stator Slots, Area of stator Slots, Length of Mean Turn, Stator Teeth, Stator Core, Rotor Design, length of air gap, Relation For Calculations of Length of air gap, No. of Rotor Slots, Design of rotor bars & Slots, (Rotor Bar Currents, Area of Rotor Bar, shapes & Size of Rotor Slots, Rotor Slot Insulations), Design of End Rings. Single and double layer single phase AC winding with integral and fractional slots, Numerical on winding.	[7]

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Unit 3: Three phase alternator:- Construction, principle of operation of three phase alternator, EMF equation, Concept of synchronous reactance and synchronous impedance, armature reaction (at unity, lagging zero and leading zero power factor) , alternator on load (resistive, inductive & capacitive). Numerical on voltage regulation.	[7]
Unit 4: Design of Alternators:- Output equation, determination of no. of poles, winding and insulation. Main dimensions stator and rotor core, slots, conductors, armature winding, calculation of reactance & armature reaction. Numerical on Output equation.	[7]
Unit 5: Synchronous Motor:- Construction, types, principle of operation of synchronous motor, armature reaction, determination of synchronous reactance, Phasor Diagram of three phase synchronous motor at Unity, lagging and leading power factor, Effect of excitation on power factor and armature current, power angle characteristics, Applications of synchronous Motor.	[7]
Unit 6: Design of Electrical Apparatus:- Detailed design of heating coils, Design of Electrical Devices Field coils, Chokes and lifting magnets.	[6]

Text Books:

1. Theory and Performance and Design of A.C. Machines, M.G. Say, ELBS London, 3rd Edition.
2. Electrical Machines, I. J. Nagrath, D. P. Kothari, Tata Mc-Graw-Hill publication IV Edition.
3. Design of Electrical Machines, K. G. Upadhyay, New age publication.
4. Principles of Electrical Machine Design, R. K. Agarwal, S. K. Katariya and sons.
5. Design of Transformers, Indrajit Dasgupta, TATA Mc-Graw Hill Publication.

Reference books:

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Sons
2. A Text Book of Electrical Engineering Drawings, K.L. Narang, Satya Prakashan, New Delhi.
3. Electrical Machine Design Data Book, A Shanmugasundaram, G. Gangadharan, R. Palani, 3rd Edition, Wiely Eastern Ltd., New Delhi.
4. A Course in Electrical Machine Design, A.K.Sawhney, Dhanpat Rai & sons New Delhi.

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Microprocessor & Microcontroller

EE503	PCC	Microprocessor & Microcontroller	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Analog and Digital Electronics

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

CO1	Explain the architecture of 8085 Microprocessor and its programming
CO2	Analyze the 8085 interfacing technique
CO3	Explain the architecture of 8051 Microcontroller and its programming
CO4	Analyze the functions of 8051 Microcontroller
CO5	Explain the architecture of Arduino Microcontroller and its features
CO6	Develop the Arduino microcontroller programming

Course Contents:

Unit 1: Architecture of 8085 Microprocessor and Programming: Introduction: Number system, Architecture of 8085 microprocessor - Registers, ALU, Bus system, Instruction formats, Addressing modes, Interrupts, Instruction set, Basic arithmetic and logical programs.	[8]
Unit 2: Interfacing: **Memory Interfacing:** Interface requirements, Address space partitioning, Buffering of Buses, interfacing SRAM, EPROM and DRAM sections. **I/O Interfacing:** Memory mapped I/O Scheme, I/O mapped I/O scheme, Input and Output cycles, Simple I/O ports, Programmable peripheral interface (8255). Data transfer schemes: Programmable data transfer, DMA data transfer, Synchronous, Asynchronous and interrupt driven data transfer schemes, Applications of microprocessors.	[7]

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Unit 3: 8051 Microcontroller: Architecture of 8051 microcontroller and pin diagram, Memory Organization, Addressing modes, Instruction set, basic arithmetic and logical programs	[7]
Unit 4: 8051 Peripheral Functions: 8051 interrupts, Timer and serial functions, parallel port features, Interfacing of 8051 - LCD interfacing and ADC interfacing.	[7]
Unit 5: Introduction to Arduino microcontroller Introduction to Arduino, Types – Uno, Mega, Micro. Arduino Uno - Pin configuration and architecture, features, digital and analog ports, I/O Functions, Sensors, serial and parallel communication.	[6]
Unit 6: Arduino microcontroller programming and Interfacing Introduction to embedded C in Arduino platform, Basic Arithmetic and logical programs. Interfacing- Display interfacing, GSM/GPRS Arduino Interfacing, ADC interfacing	[6]

Text Books:

1. Goankar, R.S., "Microprocessor Architecture Programming and Applications with the 8085/8080A", 3rd Edition, Penram International Publishing House, 1997.
2. M.A. Mazidi, R.D. McKinlay, J.G. Mazidi, "The 8051 Microcontroller: A Systems Approach", Pearson, 2013.
3. Richard Blum, "Arduino Programming", Sams Publishing, 1st Edition 2014.

Reference Books:

1. Singh. I.P., "Microprocessor Systems", Module 9: Microcontrollers and their Applications", IMPACT Learning Material Series IIT, New Delhi, 1997.
2. Douglas, V.Hall. "Microprocessor and Interfacing Programming and Hardware", 2nd Edition, McGraw Hill Inc., 1992.
3. Kenneth, L.Short., "Microprocessors and Programmed Logic", Prentice Hall of India, 2nd Edition, 1987

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Elective-II A: Industrial Automation, PLC and SCADA

EE504A	PEC	Industrial Automation, PLC and SCADA	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Electrical and Electronic Measurements and Instrumentation

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

CO1	Explain role of automation in industry and different ways of industrial automation
CO2	Explain role of PLC in industrial automation.
CO3	Explain various operations of PLC
CO4	Develop programs using ladder programming for PLC
CO5	Explain architecture of SCADA systems
CO6	Explain operation of elements of SCADA

Course Contents:

Unit 1: Industrial Automation Process Definition of process, Meaning of Automation and Control Role of automation in process Industry, Architecture of Industrial Automation Network. Types of Automation systems, Role of information in process automation, Process automation with smart intelligent instruments, Challenges of process automation, industry 1.0 to industry 4.0.	[6]
Unit 2: Programmable Logic Controller (PLC) Invention of PLC, Sustainability of PLC, Definition of PLC, Classification of PLC's, Role of PLC in Automation, Feature of a PLC, I/O devices of PLC, PLC programming devices, PLC Selection criteria, major PLC vendors and their products, Top five PLC Vendors.	[6]
Unit 3: Design and operation of PLC Design and operation of PLC, Architecture of PLC, Central Control Unit of PLC, Functional modes of PLC, PLC Program structure and execution, Programming devices for PLC,	[5]

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Selecting I/O devices for PLC -Sourcing and Sinking, Programming Languages, IEC611g Languages, IEC61131-structuring resource, Ladder diagram.	
Unit 4: PLC Programming Variables and Data types, Register, Timer, On delay timer, off delay timer, pulse timer, Counter, Up counter, Down counter, Arithmetic functions-Addition(ADD), Subtraction(SUB), Division(DIV), Square root(SQRT), Data handling functions-MOVE(MV), Block Transfer(BT), TABLE AND REGISTER MOVE, Matrix function, Analog Signal handling, PID control with PLC, Digital bit function, Shift register function, Sequence function.(simple illustrative programs are expected)	[8]
Unit 5: SCADA System Introduction, Different SCADA System Topologies. SCADA Architectures-First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture, Functions of SCADA- Data acquisition, Data communication-Message Based polling mode, standard polling mode, polled report by exception, data presentation control.	[6]
Unit 6: Elements of SCADA Master Terminal Unit (MTU), Remote Terminal Unit (RTU)- RTU Topology, RTU requisites, RTU hardware and functionality, RTU software functions, Operation of RTU, Field data devices and interfacing- Human Machine Interface(HMI), Human Computer Interface (HCI), PLC based process control system. Alarm handling. Application areas of SCADA.	[5]

Text Books:

1. Industrial Automation Technologies by Chanchal Dey Sunit Kumar Sen, CRC Press.

Reference Books:

1. Industrial Automation Hand Book by Frank. Lamb Tata Mcgraw Hill India
2. Introduction to Industrial Automation by Stamatios Manesis George Nikolakopoulos CRC Press.
3. Programmable Logic Controllers by John Webb, Ronald A. Reis. PHI.

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Elective-II B: Python Programming

EE504B	PEC	Python Programming	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Describe the numbers, math functions, strings, tuples and lists in Python
CO2	Express different decision-making statements and Functions.
CO3	Interpret object-oriented programming in Python.
CO4	Demonstrate and summarize different file handling operations.

Course Contents:

Unit 1: Problem Solving Strategies Problem Analysis, Algorithms, Flow Charts, Introduction to Python : Introduction, python overview, getting started with python – installing python interpreter, simple python program, comments, python identifiers, reserved keywords, variables, standard data types, operators, statements and expressions, string operations, Boolean expressions, control statement, iteration, input from keyboard	[6]
Unit 2: Functions Functions: Built-in-functions, composition of functions, user defined functions, parameters and arguments, functions calls, the return statement, python recursive functions, the anonymous functions, writing python scripts.	[6]
Unit 3: Strings and Lists Strings- compound data type, len function, string slices, strings are immutable, strings traversal, escape characters, string formatting operator, string formatting functions and Lists value and accessing elements, lists are mutable, built-in list operators, built-in methods.	[6]
Unit 4: Tuples and Dictionaries	[6]

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Tuples-creating tuples, accessing values in tuples, tuples are immutable, tuple assignment, tuples as return value, variable-length argument tuples, basic tuples operations, built-in tuple functions and Dictionaries- creating a dictionary, accessing values in a dictionary, updating dictionary, deleting elements from dictionary, properties of dictionary keys, operations in dictionary, built-in dictionary methods.	
Unit 5: Files and Exceptions Files- Text files, directories, exceptions- built-in exceptions, handling exceptions, exceptions with arguments, user defined exceptions.	[6]
Unit 6: Classes and Objects Overview of OOP, class definition, creating objects, objects as arguments, objects as written/return values, built-in class attributes, inheritance, method overriding, data encapsulation, data hiding. Graphical User Interface: Tkinter- pack(), grid() and place() methods. Widgets - button, canvas, check button, entry, frame, label, list box, menu button, message, scale, scrollbar, text.	[6]

Text Books:

1. Introduction to Computing and Problem Solving Using Python, E Balagurusamy McGraw Hill Education Pvt. Ltd.
2. Programming and Problem Solving with Python, Kamthane, McGraw Hill Education Pvt. Ltd.
3. Python: The Complete Reference, Brown, McGraw Hill Education Pvt. Ltd

Reference Books:

1. "Python Programming: An introduction to Computer Science", John Zelle, Franklin, Beedle and Associates, Inc.
2. "Learning Python" , Mark Lutz, O'reilly, 5e
3. "Programming in Python",R. Pooja Sharma, BPB Publications

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Elective-II C: Power System Operation and Control

EE504C	PEC	Power System Operation and Control	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain Power System Operation.
CO2	Explain Real Power and Frequency Control.
CO3	Explain Reactive Power and Voltage Control.
CO4	Determine Economic Operation of Power System.
CO5	Explain Computer Control of Power System.
CO6	Explain Power System Security.

Course Contents:

Unit – 1 Power System Operation National and Regional load dispatch centers, requirements power system, necessity of voltage and frequency regulation, system load variation, load dispatching, load forecasting, sped governing mechanisms and modeling, sped load characteristics – regulation of two generators in parallel.	[6]
Unit – 2 Real power and frequency control Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases , LFC of two area system, block diagram representation of two area system tie line modeling , static and dynamic analysis of load , tie line with frequency bias control , ,integration of economic dispatch control with LFC	[6]
Unit-III Reactive Power and Voltage Control Generation and absorption of reactive power, Automatic Voltage Regulator (AVR) , block diagram representation of AVR, brushless AC excitation system , stability compensation,	[6]

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concept of blackout in power system, methods of reactive power control- tap changing transformer, SVC (TCR+TSC) and STATCOM.	
UNIT IV Economic Operation of Power System concept of economic dispatch problem, input and output characteristics of thermal plant, incremental cost curve, optimal operation of thermal units without and with transmission loses (no derivation of transmission los coefficients), numerical treatment on economic dispatch statement of unit commitment (UC) problem, constraints on UC problem, solution of UC problem using priority list, special aspects of short term and long term hydrothermal problems.	[8]
UNIT V Computer Control of Power Systems Need and importance of computer control in power systems, Phasor Measurement Unit (PMU) for system monitoring, data acquisition and controls in power system, SCADA and EMS functions.	[8]
UNIT VI: Power System Security Power System State Classification, factors affecting power system security, Power system Security, security assessment- system monitoring, Contingency Analysis, security control	[6]
Text Books: 1. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, TMH Publication 2. Power System Analysis – Hadi Saadat, Mc-GrawHill series publication	
Reference Books: 1. An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems –A Chakrabarti, D P Kothari, A K Mukhopadhyay, Abhinandan D E, PHI 2. Electrical Power Systems – P. Venkatesh, B.V. Manikandan, S.C. Raja, A. Srinivasan, PHI 3. Power System Analysis – J. J. Grainger, W.D. Stevenson, Mc-GrawHill series publication 4. Power Generation Operation and Control – A. J. Wood, B. F. Woolenberg, John Wiley and Sons 5. Advanced Power System Analysis and Dynamics – L. P. Singh, New Age International 6. Operation of Restructured Power Systems – K. Bhattacharya, H. J. Bollen, J. E. Daalder,Kluwer academic publishers	

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Elective-II D: Energy Audit & Conservation

EE504D	PEC	Energy Audit & Conservation	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs./week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Physics, Basic Electrical Engineering

Course objectives:

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

CO1	Interpret the basic terminologies associated with energy audit and conservation
CO2	Explain process involved in the energy audit
CO3	Explain the concepts of thermal and mechanical systems which associated in the process of the energy audit
CO4	Explain the concepts of electrical systems which associated in the process of the energy audit
CO5	Explain the terminologies of Financial Management associated in the process of energy audit
CO6	Select the appropriate method for planning and monitoring of energy conservation projects

Course Contents:

Unit 1: Global Environmental Concerns: Global Environmental Issues, United Nations Framework Convention on Climate, Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Clean Development, Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable Development.	[5]
Unit 2: Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	[6]

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Unit 3: Thermal & Mechanical Systems: Boilers: Types, Combustion in boilers, Performances evaluation- Direct Method & Indirect Method of Boiler Efficiency, Energy conservation opportunities; Pumps and Pumping System: Types, Performance evaluation, Energy conservation opportunities; Cooling Tower: Types and performance evaluation, Energy saving opportunities; Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials.	[8]
Unit 4: Electrical Systems: Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls	[7]
Unit 5: Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs.	[6]
Unit 6: Case Studies Planning, Implementation & monitoring of energy conservation project, Case studies on various Industrial Sectors and Commercial Establishments.	[4]
Text Books: 1. "Industrial Energy Conservation", Charles M Gottschalk, John Willey and Sons. 2. "Energy Management Handbook", Paul O Callagham, Tata Mc Graw Hill 3. "Energy Technology", S. Rao and B. Parulekar, Khanna Publishers	
Reference Books: 1. "Energy Management Handbook", Wayne C. Turner	

Power Electronics Laboratory

EE505	PCC	Power Electronics laboratory	0-0-2	1 Credits

Teaching Scheme	Examination Scheme
Practical: 2 hrs /week	CA-I: 15 Marks CA-II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Basic Electrical Engineering.

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

CO1	Examine the firing circuit & characteristics of power semi converter devices
CO2	Analyze the ac to dc converter circuit
CO3	Analyze the dc to ac converter
CO4	Analyze the operation of dc to dc & ac to ac converter

List of Experiment [Minimum of 8 Mandatory]

1. To obtain V-I characteristics of SCR & determine latching current, holding current forward breakdown voltage.
2. To obtain V-I characteristics of IGBT (out characteristics & transfer characteristics)
3. To study firing circuit of SCR.
4. To determine output voltage current of single phase half wave controlled converter for R, RL & RLE Load.
5. To determine output voltage current of symmetrical & asymmetrical semi controlled converter.
6. To control the intensity of lamp by using ac voltage controller by using TRIAC & DIAC.
7. To study MOSFET/IGBT based single phase bridge inverter.
8. To study single phase cycloconverter.
9. To study DC Jones chopper with R & RL Loads.
10. To study single phase dual converter with RL Load.
11. To simulate three phase fully controlled rectifier for R,RL & RLE & Plot the waveform
12. To simulate three phase inverter.
13. To conduct survey/field visit to study applications of rectifier, inverter, chopper & ac voltage controller.

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AC Machines laboratory

EE506	PCC	AC Machines laboratory	0-0-2	1 Credits

Teaching Scheme	Examination Scheme
Practical: 2 hrs /week	CA-I: 15 Marks CA-II: 15 Marks End Semester Examination: 20 Marks

Pre-Requisites: Basic Electrical Engineering.

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

CO1	Design 3-ph Induction motor with Determination of its performance characteristics
CO2	Design Alternator with Determination of its performance characteristics
CO3	Test Synchronous Motor

List of Experiment [Minimum of 8 Mandatory]

1. Determination of equivalent circuit parameters of 3 Ph SCIM by conducting No Load & Blocked Rotor Test.
2. Study of starters and Speed control methods for 3 Ph induction motors.
3. Determination of efficiency & speed regulation of 3 phase Squirrel cage induction motor by direct loading method.
4. Determination of efficiency & speed regulation of 3 phase slip ring induction motor by direct loading method.
5. Determination of efficiency of Alternator by direct loading method
6. Determination of Voltage regulation of an alternator by EMF method
7. Determination of Voltage regulation of an alternator by MMF method
8. Determination of Voltage regulation of an alternator by ZPF method
9. Determination of V and Inverted V curves of a synchronous motor
10. To design 3-ph Induction Motor by using software tools
11. To design 3-ph Alternator by using software tools
12. To study design of 3-ph Induction Motor by field visit

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Microprocessor & Microcontroller Laboratory

EE507	PCC	Microprocessor & Microcontroller Laboratory	0-0-2	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: - Tutorial: -- Practical: 2hr/week	CA-1: 15 Marks CA-2: 15 Marks End Semester Examination: 20 Marks

Pre-Requisites: Analog and Digital Electronics.

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

CO1	Develop 8085 microprocessor arithmetic and logical programs
CO2	Develop 8051 microcontroller programs
CO3	Build Arduino Microcontroller programs for basic applications.

List of Experiments [Minimum of 8 Mandatory]

1. Assembly language program's for 8085 arithmetic operations
2. Assembly language program's for 8085 logical operations
3. Rolling display using 8051 microcontroller
4. led flashing using 8051 microcontroller
5. Speed and direction control of dc motor using 8051 microcontroller
6. Speed and direction of stepper motor using 8051 microcontroller
7. Automatic Street light control using 8051 microcontroller
8. Seven segment display using 8051 microcontroller
9. IR obstacle sensor using Arduino microcontroller
10. Relay control using Arduino microcontroller
11. Temperature controlled fan using Arduino microcontroller

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Aptitude Skills-III

HMS05	HSMC	Aptitude Skills-III	1-0-0	1 Credit

Teaching Scheme:	Examination Scheme:
Practical: 1hr/week	CA-1: 25 Marks CA-2: 25 Marks

Pre-Requisites: Communication Skills, Aptitude Skills I, II

Group A

Aptitude (12Hrs) (Compulsory)

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

1	Solve the problems on system of equation
2	Solve the problems on seating arrangement
3	Solve the logical reasoning problems
4	Solve the critical analysis problems
5	Solve the problems of Data interpretation
6	Solve the problems of permutations and Combinations

Course Contents:

Unit 1: System of equations Quadratic equations, Surds and indices, solution of equations, Ages.	[2]
Unit 2: Seating Arrangements Linear seating Arrangement, Circular seating arrangement, Complex seating arrangement	[2]
Unit 3: Logical Reasoning Numerical based on sense of direction, Blood relations, Odd man Out	[2]
Unit 4: Critical analysis Clocks and Calendar based problems, Cryptarithmetic, heights and distances	[2]
Unit 5: Data Interpretation Table form, Bar form, Line for Pi chart form	[2]
Unit 6:Permutations and Combinations Numbers and Words Repetition allowed and Repetition not allowed	[2]

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Text Books:

1. RS Aggarwal "A Modern Approach to Verbal & Non-Verbal Reasoning", S. Chand Publisher; 2016 edition
2. RS Aggarwal, " Quantitative Aptitude for Competitive Examinations", S. Chand Publisher; 2016 edition
3. Raymond Murphy "Essential English Grammar with Answers", Murphy

Reference Books:

1. Rao N,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press;Second edition
3. RS Aggarwal, Objective General English, S. Chand Publisher; 2016 edition

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Group B

Verbal Ability (12Hrs) (Compulsory)

Pre-Requisites: Communication Skills Aptitude Skills I, II

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

1	Understand basic concepts of sentences and its structure
2	Understand the tenses and its use in daily life
3	Explain basic uses of speeches and voices in day to day life
4	Understand the use of modal verbs in sentence construction
5	Summarize various Phrases, Idioms and Proverbs
6	Summarize different words used in daily life

Course Contents:

Unit 1: Parts of Speech, Word Family (Using the same word as different Parts of Speech), Punctuation.	[2]
Unit 2: Analogy, Letter Writing (Formal), E-Mail Writing, CV Writing	[2]
Unit 3: Reading Comprehension, Paragraph Jumbles.	[2]
Unit 4: Spotting Errors (in different parts of sentence), Subject-Verb Agreement, Sentence Correction, Sentence Completion.	[2]
Unit 5: One Word Substitution, Narrating Events/Reports, Summary/Precise Writing	[2]
Unit 6: Dialogue Writing, Group Discussion, Interview Skills (Using formal notations & gestures etc.)	[2]

Text Books:

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S. Aggarwal, S Chand Publishing; Revised edition (15 March 2017)

Reference Books:

1. RaoN,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press;Second edition.

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Language Skills-III

HMS06	HSMC	Language Skills-III	0-0-2	Audit

Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	CA-1: 25 Marks CA-2: 25 Marks

Pre-Requisites: Language Skills I, II

Languages (Any One)

Python (Technical Language) (24Hrs)

Syllabus for Python

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

CO1	Explain essentials and fundamentals of Python Programming
CO2	Illustrate data types and variables.
CO3	Illustrate Operators and Expressions.
CO4	Make a use of Decision making and Looping statements.

Course Contents:

Unit 1: Introduction What is Python, what can python do, why python, how to use Python, Python indentation, pythoncomments, basic syntax of program, first program of Python.	[6]
Unit 2: Variable and data types Creating variable ,casting, variable name ,global variable, local variable, built in data-types, string, constructor, function of data-type , type conversion	[6]
Unit 3: Operators in Python Unary Operator, Binary operator (arithmetic operator, logical operator ,assignment operator, membership operator ,identity operator, bitwise operator) , ternary operator	[6]
Unit 4: Statements and loops Input & Output Statements ,Conditional Statements ,Simple if Statement ,If-else statement , Else-ifLadder, Nested if statement, ,while loop ,for loop ,break ,continue ,pass statements	[6]

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Mini Project- IV

PRJ04	PROJ	Mini Project- IV	0-0-2	1 Credit

Teaching Scheme:	**Examination Scheme:**
Lecture: - Tutorial: -- Practical: 2hr/week	CA-1: 25 Marks CA-2: 25 Marks

Pre-Requisites:

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

CO1	Select the appropriate method for solving the problem.
CO2	Make use of various engineering techniques and tools to give a solution.
CO3	Justify the method/tools used to develop the solution.
CO4	Demonstrate tangible solutions to the problem
CO5	Describe the solution with the help of a project report and presentation.

About Mini Project- IV

The project is a part of addressing societal and industrial needs. Mini Project is one of the platforms that students will use to solve real-world challenges. This course focuses on the selection of methods/engineering tools/analytical techniques for problem-solving. Through this course, students gain a thorough understanding of engineering basics and ideas, gain practical experience, have the opportunity to display their skills and learn about teamwork, financial management, communication skills, and responsibility.

Guidelines

1. Every student shall undertake the Mini Project-IV activity for semester V.
2. Minimum three and maximum of five students should work together in Mini Project-IV.
3. The students have to work on different approaches and finalize the best methodology to solve the problem in consultation with the project guide.
4. The students should use different tools /Techniques for the development of the solution to the problem.
5. While developing solutions, the student can take care of effective use of resources, follow ethical practices, finance management,
6. The solution should be optimal, affordable, user-friendly and environment friendly.
7. Critically analysis and testing of the solution provided.

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8. By using IPR, students should reserve their rights of innovations as well as communicate new findings to society with the help of research papers.

The committee of senior faculty members and a project guide will be appointed to monitor the progress and continuous evaluation of each project. The assessment shall be done jointly by the guide and committee members.

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Teaching and Evaluation Scheme for TY B. Tech.

Department of Electrical Engineering

Semester: VI

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Department: Electrical Engineering

Rev: Course Structure/00/2021-22

Class: T.Y. B. Tech.

Semester: VI

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
EE601	PCC	Linear Integrated Circuits	3	--	--	3	10	10	30	50	100	3
EE602	PCC	Electric Drives	3	--	--	3	10	10	30	50	100	3
EE603	PEC	Elective-III	3	--	--	3	10	10	30	50	100	3
	OEC	Open Elective-II	3	--	--	3	10	10	30	50	100	3
EE604	PCC	Switchgear and Protection	3	--	--	3	10	10	30	50	100	3
EE605	PCC	Switchgear and Protection Laboratory	--	--	2	2	15	15	--	20	50	1
EE606	PCC	Linear Integrated Circuits Laboratory	--	--	2	2	15	15	--	20	50	1
EE607	PCC	Electric Drives Laboratory	--	--	2	2	15	15	--	20	50	1
EE608	PROJ	Mega Project Phase –I (Seminar)	--	--	4	4	25	25	--	50	100	2
IFT02	PROJ	Industrial Training/ Field Training	--	--	--	--	25	25	--	--	50	Audit
HMS07	HSMC	Aptitude Skills-IV	1	--	--	1	25	25	--	--	50	Audit
HMS08	HSMC	Language Skills-IV	--	--	2	2	25	25	--	--	50	1
Total			**16**	**--**	**12**	**28**	**195**	**195**	**150**	**360**	**900**	**21**

Elective-III A. Neural Networks and Fuzzy Logic

B. IOT Fundamentals

C. Deregulated Power Systems

D. E-Mobility

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Linear Integrated Circuits

EE601	PCC	Linear Integrated Circuits	3-0-0	4 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Analog and Digital Electronics, Circuit Analysis

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

CO1	Explain various parameters of OP-AMP
CO2	Design Linear Circuits using OP-AMP
CO3	Design Filter circuits using OP-AMP
CO4	Design Analog to Digital and Digital to Analog converters.
CO5	Design waveform generator using OP-AMP
CO6	Explain the working of special function IC's.

Course Contents:

Unit-I Basics of OP-AMP: Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate.	[7]
Unit II Applications of OP-AMP: Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator.	[6]

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Unit III Filter Circuits Using OP-AMP: Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass filters.	[6]
Unit IV Analog To Digital And Digital To Analog Converters: Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2 Ladder type, Voltage Mode and Current-Mode R – 2R Ladder types – switches for D/A converters high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type	[8]
Unit V Waveform Generators: Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555,	[6]
Unit VI Special Function IC's: IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Low Drop–Out (LDO) Regulators – Switched capacitor filter IC MF10, Audio Power amplifier.	[7]
Text Books: 1. Operational Amplifier and Linear Integrated Circuits by David Bell, TMH 2. OP-AMPS and Linear Integrated Circuit Technology by Ramakant A. Gaikwad, PHI	
Reference Books: 1. Linear Integrated Circuits by Roy Choudhary, Shail B Jain 2. Linear Integrated Circuits and Applications by R. P. Punagin, Willey 3. Linear Integrated Circuits by K. Salivahan, TMH 4. Operational Amplifier with linear Integrated Circuits by William D Stanley, Pearson	

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Electrical Drives

EE602	PCC	**Electrical Drives**	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 4 hrs./week Tutorial: --	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power Electronics, Electrical Machines

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

CO1	Explain the basic characteristics and fundamental equations of AC & DC motors.
CO2	Analyze control techniques of DC motor drives.
CO3	Analyze control techniques of Induction motor drives.
CO4	Analyze control techniques of Synchronous motor Drives.
CO5	Analyze control techniques of special purpose motor dives.
CO6	Select motors for different applications.

Course Contents:

Unit I Introduction: Dynamics of Electric Drives, Fundamental torque equation, types of loading, components of load torque, Steady State Stability, Load equalization. Closed loop control of drives, Selection of motor power rating.	[7]
Unit II DC Motor Drives: Braking and Speed Control, Ward Leonard Drives, Phase controlled converter fed DC drives, Dual-converter control of DC drives, Supply harmonics, Power factor and ripple in motor current, Chopper Control of DC drives.	[7]
Unit III Induction Motor Drives:	[8]

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Control of Induction Motor Fed from VSI and CSI, Operation of Induction Motor with Unbalanced Source Voltages and single phasing, Analysis of Induction Motor from Non-sinusoidal Voltage Supply; Slip power recovery-Static Scherbius and Cramer drives, Linear Induction Motors. **Variable Frequency Drives(VFD):**Basics schematic of VFDs, Design of VFD drives, Benefits of VFDs, Industrial applications of VFDs.	
Unit IV Synchronous Motor Drives: Starting, Pull in and braking of synchronous motors, Speed control– variable frequency control, cycloconverters control.	[7]
Unit V Special Purpose Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. Brushless DC Motor drives, Servo motor drives.	[7]
Unit VI Industrial Drives Applications: **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.	[8]

Text Books:

1. G. K. Dubey : Fundamentals of Electrical Drives, 2nd Edition, Alpha Science International, 2001.
2. R. Krishnan: Electric Motor drives - Modelling, Analysis and Control, PHI India Ltd., 2002.
3. B.K. Bose, "Modern Power Electronics & AC drives", Prentice Hall Publisher, 2002
4. T. Kenjo, Stepping Motors and their Microprocessor Control, England, Clarendon Oxford Press, 1985
5. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, New Delhi, Prentice, Hall of India, 2009

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A: Neural Networks and Fuzzy Logic

EE603A	PEC1	Neural Networks and Fuzzy Logic	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs./week Tutorial: --- Practical: ---	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 50 Marks End Semester Exam: 50 Marks Term Work: --- Practical and Oral Exam:---

Course objectives:

1	To review basic principles of neuron structure
2	To understand building blocks and different networks of neural network
3	To study the different algorithm for learning
4	To understand the fuzzy system and hybrid fuzzy neural networks

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

CO1	Explain basic principles of neuron structure and different algorithm for learning
CO2	Explain the single layer and multilayer perceptrons
CO3	Explain the radial basis function networks
CO4	Illustrate the concept of self-organizing maps
CO5	Explain the fuzzy sets and fuzzy systems
CO6	Interpret the hybrid fuzzy neural networks

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Course Contents:

Unit 1: ANN Structure and Learning Processes Biological Neurons, Models of Neurons, Types of Activation functions- Threshold, Piecewise-Linear, Sigmoid, Network Architectures, State-space concepts, Error-correction learning, Memory-based learning, Hebbian learning, Competitive learning.	**[8]**
Unit 2: Perceptrons Single Layer Perceptrocs: Structure of perceptrons, Least Mean Square Algorithm, Perceptron Convergence Theorem, Bayes Classifier. Multilayer Perceptrons: Structures of Multi-layer Feedforward Networks, Back Propagation Algorithm, Limitations of Back Propagation Algorithm.	**[8]**
Unit 3: Radial Basis Function Networks Pattern separability, Interpolation, Regularization Theory, Regularization Network, Radial Basis Function (RBF) Network, Comparison of RBF Network and Multilayer Perceptron.	**[6]**
Unit 4: Self Organizing Maps Two Basic Features of Mapping Models, Self Organizing Map, Properties of Feature Map, Learning Vector Quantization, Contextual Maps.	**[6]**
Unit 5: Fuzzy Sets and Fuzzy Systems Fuzzy Sets, Membership Functions, Geometry of Fuzzy Sets, Simple Operations on Fuzzy Sets, Rule Composition and Defuzzification.	**[6]**
Unit 6: Hybrid Fuzzy Neural Networks Introduction, Hybrid System, Fuzzy Logic in Learning Algorithm, Fuzzy Neurons, Neural Network as Pre-processor or Post-processor, Neural Networks as Tuner of Fuzzy Logic Systems, Advantages and Drawbacks of Neurofuzzy Systems, Adaptive Neuro-Fuzzy Inference System (ANFIS)	**[6]**
Text/Reference Books 1. "Neural Networks: A Classroom Approach", Satish Kumar, Mc Graw Hill.	

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2. "Fuzzy Logic and Neural Networks: Basic Concepts & Applications", Chennakesava R Alavala, New Age International Publishers. 3. "An Introduction to Fuzzy Logic and Fuzzy Sets", James J. Buckley, Esfandiar Eslami, Springer.	
Reference Books 1. "Neural Networks- A Comprehensive Foundation", Simon Haykin, Pearson Education (US).	

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B: IoT Fundamentals

EE603	PEC	IoT Fundamentals	3-0-0	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Microprocessor and Microcontrollers

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

CO1	Explain Functional blocks of IoT.
CO2	Infer communication protocols of IoT.
CO3	Develop IoT applications using Arduino.
CO4	Develop IoT applications using Raspberry Pi and Python programming .
CO5	Implement IoT applications and carry out Data handling and analytics.
CO6	Implement IoT solutions in Smart Homes, Smart Cities and Smart Grids etc.

Course Contents:

Unit-I Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.	[7]
Unit II Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT.	[6]
Unit III Introduction to Arduino, Working of Arduino, Programming of Arduino, Integration of Sensors and Actuators with Arduino.	[6]
Unit IV Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi	[6]

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Unit V Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,	[6]
Unit VI Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring switching regulator, Low Drop–Out (LDO) Regulators – Switched capacitor filter IC MF10, Audio Power amplifier.	[7]

Text Books:

1. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Make sensors": Terokarvinen, kemo, karvinen and villey valtokari, 1st edition, maker media,2014.
3. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti

Reference Books:

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
3. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress.

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C: Deregulated Power System

EE603	PEC	Deregulated Power System	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power System

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

CO1	To explain the traditional regulated structure of the electric industry
CO2	To explain the deregulated structure of the electric industry
CO3	To compare regulation and deregulation of electric utilities
CO4	To analyze the wholesale power marketplace
CO5	To analyze power distribution in the deregulated industry
CO6	To explain the deregulation scenario in India

Course Contents:

Unit I: The Electric Industry and Its Traditional Regulated Structure Electric Utility Functions and Systems - Electric Utility Resources and Organization - Vertical Integration and Monopoly Regulation - Electric Utility Business Frameworks - Government Regulatory Agencies and Commissions	[7]
Unit 2: The Electric Industry Under De-Regulation De-Regulation: Concepts and Evolution, Competition at the Wholesale Generation Level, Independently Operated Regional Transmission Grids, History of the Electric Power	[7]

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Industry: Growth of Electrical Usage - The Growth of Electrical Systems Technology - The Rise of the Electrical Utility Industry	
Unit 3: Distributed Generation and Storage Distributed Power Generation - Types of Distributed Generators - Distributed Power Storage, Regulation and De-Regulation: Why Were Electric Utilities Regulated? Why De-Regulate?, The Good and Bad of Utility Regulation, Goals for De-Regulation and Effects of De-Regulation	[6]
Unit 4:De-Regulation at the Wholesale Power Level Comparing Four Approaches to Regulation and De-Regulation - Increased Services From and Financial Pressures on LDCs, The Wholesale Power Marketplace – bidding of electricity - Buying Energy vs. Buying Capacity - Wholesale Power Pricing	[7]
Unit 5: Power Grid and Power Distribution in the De-Regulated Industry Generation and Transmission in a De-Regulated Industry - The Wholesale Transmission Level - Transmission Service Pricing- Location Based Pricing, Open Access Distribution - Changes in Distribution Operations - Will Distribution Performance Improve Due to "Competition"	[7]
Unit 6:Retail Sales in a Fully De-Regulated Industry Retail Sales in a Fully De-Regulated Industry: Load Aggregation and Services - RESCO Identities and Industry Position. Deregulation Scenario in India – Indian Electricity Act 2003.	[6]
Text Books: 1. Understanding Electric Utilities and De-Regulation, H. Lee Willis, Lorrin Philipson, CRC Press, 2nd Edition. 2. Power System Restructuring and Deregulation" John Wiley and Sons, Lei Lee Lai. 3. Power System Economics: Designing markets for electricity - S. Stoft, wiley.	

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Electrical Engineering
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Yadrav (Ichalkaranji) Dist.Kolhapur

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D: E-MOBILITY

EE603	PEC	**E-MOBILITY**	3-0-0	3 Credits

Teaching Scheme:	Evaluation Scheme:
Lecture: 3 hrs/week Tutorial: -- Practical: --	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Electrical Engineering, Electrical Machines, Power Electronics

Course Outcomes:

At the end of the course, the students will be able to:

CO1	**Illustrate** development scenario of EVs and the challenges of EVs.
CO2	**Determine** the battery parameters used in different batteries with EVs.
CO3	**Identify** the motors for drive technologies to EVs (BEV, HEV & FCEV).
CO4	**Demonstrate** the power electronics convertors used for EVs.
CO5	**Develop** range modeling of an electric vehicles and hybrid electric vehicles.
CO6	**Explain** Electric Vehicle communication and its applications.

Course Contents:

UNIT-I: Introduction Understand Mobility and its evolutions, Electric Mobility and Environmental Impact Reduction, Economic Analysis, Electric Mobility and Infrastructures: Technical and Economic Dimensions, Electric Mobility Today, Prospective: The Road to Electrification, Overview of EVs and challenges, and Technologies.	[6]
UNIT-II: Batteries **Batteries:** Electrochemical Batteries: Battery Parameters: Battery Capacity, Open Circuit and Terminal Voltages, Charge/Discharge Rate, State of Charge/Discharge, Depth of Discharge,	[6]

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Battery Energy Density and Specific Energy, Battery Power Density and Specific Power, Battery Efficiency, Electrochemical Batteries-Types, Ultracapacitors, Ultrahigh-Speed Flywheels, Numerical Problems.	
UNIT-III: Electric and Hybrid Powertrain Technologies Introduction, BEVs, Electric Traction Motors, DC Motors-BLDC Motor, AC Motors-IM, PMSM, SR Motors, Energy sources and Energy carriers, Hybrid Electric Vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), FCEV.	[6]
UNIT-IV: Power-Electronic Converters for EV Applications DC/DC Converters: Non-isolated converters: buck, boost, buck-boost, Cuk and charge-pump converters; bi-directional converters; Isolated converters: Half-Bridge, Full-Bridge, Fly-back, Forward and Push-Pull DC/DC converters; DC/AC Converter; Resonant DC-link Inverter.	[7]
Unit-V: Electric Vehicle Modelling Introduction, Tractive Effort, Rolling resistance force, Aerodynamics, Hill climbing force, Acceleration force, Total tractive effort , Modelling Vehicle Acceleration, Acceleration performance parameters, Modelling the acceleration of an electric scooter, Modelling the acceleration of a small car, Range modelling of battery electric vehicles, Range modelling of hybrid electric vehicles.	[7]
UNIT-VI: EV Communication Basic Communication, V2V, V2G and its applications in power system - power saving & coordinated charging - layout of power converters for V2G operation, EV configurations: converted & purpose built EVs components of EV system, Wireless Power Transfer: Principle, Stationary WPT, and Dynamic WPT.	[6]

Text Books:

1. Electric-Vehicle-Technology-Explained, James Larminie and John Lowry, John Wiley & Sons Ltd, 2012.
2. Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Husain, CRC Press, 2010.

Reference Books:

1. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz M. Ebrahimi, CRC Press,2018.
3. Hybrid Electric Vehicle System Modelling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

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Switchgear and Protection

EE604	PCC	Switchgear and Protection	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power System, DC & AC Machine

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

CO1	Explain Circuit Breakers
CO2	Explain Protective relaying used for power system protection
CO3	Explain Digital & Numerical Protection
CO4	Select Protection schemes used for protection of Alternator & Transformer
CO5	Select Protection schemes used for protection of Bus bar, Feeder and Transmission line
CO6	Explain Insulation co-ordination and Over Voltage Protection

Course Contents:

Unit I: Circuit Interruption Voltage-current characteristics of arc, Principles of circuit interruption, arc phenomenon, A.C. and D. C. circuit breaker, Restricting and recovery voltage. Arc quenching methods, current chopping. Capacitive, inductive current breaking, resistance switching, Auto reclosing Circuit Breakers: Construction, working and application of Air blast, Bulk oil, Minimum oil, SF6 and Vacuum circuit breakers, Circuit breaker ratings, HVDC breakers ,H. R. C. fuses & its applications. Construction, working and application of MCB & MCCB	[8]
Unit II: 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,	[8]

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Principle of working and characteristics of attracted armature, balanced beam, induction, disc and cup type relays, induction relays, Current Setting & Time setting of Overcorrect relay, Time-current characteristics of over current Relays; directional, differential, percentage differential and distance (impedance, reactance, mho) relays, introduction to static relays	
Unit III: Digital and Numerical Protection: Introduction, Advantages & Disadvantages of Numerical relays, Numerical relaying algorithms techniques Diff. methods of Digital and Numerical protection, Numerical over current protection, Numerical Distance protection, Numerical Differential protection	[6]
Unit IV: Protection of Alternators and Transformers: Alternators – Stator fault, stator inter turn protection, Percentage differential protection system, Negative phase sequence [NPS] protection, Excitation Failure & Protection against motoring Transformer – Use of Buccholz relay, differential protection, connection of C. T. and calculation of C.T. ratio needed for differential relaying, restricted earth fault protection, Frame leakage protection, Generator-Transformer unit protection	[8]
Unit V: Protection of Bus bar, Feeder and Transmission line: Bus bar protection, circulating current protection and Transmission line protection using over current relays. Principles of distance relaying, choice between impedance, reactance and mho types, pilot wire and carrier pilot protection.	[7]
Unit VI: Insulation co-ordination and Over Voltage Protection: Definitions (Dry flashover voltage FOV), WEF FOV, Impulse FOV, insulation, coordinating 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, Methods of earthing, Neutral earthing & its types.	[7]
Reference & Text Books: 1. Sunil S. Rao – Switchgear & Protection , Khanna Publications (Tata Mcgraw Hill). 2. Power System Protection and Switchgear: B.Ram and B.N. Vishwakarma 3. Patara Basu & Chaudhary – Power System Protection.(New Delhi Oxford And IBH). 4. Digital Protection: L.P.Singh	

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Electrical Engineering
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Switchgear and Protection Laboratory

EE605	PCC	Switchgear and Protection Laboratory	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Laboratory: 2 hrs/week	CA-I: 15 Marks CA-II: 15 Marks End Semester Examination: 50 Marks

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

CO1	Select over current relay for different applications.
CO2	Explain microprocessor based impedance relay.
CO3	Demonstrate Power system protection equipment's.

List of Experiments:

1. Experimental study of working of electromechanical over current relay.
2. Experimental study of working of a Directional over current relay.
3. Experimental realization of microprocessor based over current relay.
4. Experimental study of working of microprocessor based impedance relay.
5. Demonstration of LT Switchgear by Industrial visit
6. Demonstration of operation of protections systems for Feeder, Transmission lines by Industrial visits
7. Study of Transformer protection system in substation by Industrial visits.
8. Study of Generator protection system by field visit.

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Linear Integrated Circuits Laboratory

EE606	PCC	Linear Integrated Circuits Laboratory	0-0-2	1 Credits

Teaching Scheme	**Examination Scheme**
Practical: 2 hrs/week	CA-I: 15 Marks CA-II: 15 Marks Practical Oral Exam: 20 Marks

Pre-Requisites: Analog and Digital Electronics, Circuit Analysis

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

CO1	Determine, average DC output voltage, ripple factor and Capacitor filter for Rectifier circuits
CO2	Design Analog Circuits using BJT
CO3	Design Linear circuits using OP-AMP(Ic-741)

List of experiments

1. Study of basic electronic components: color coding of resistors, selection of capacitors, circuit symbols, CRO, Function generator.
2. Design Half wave rectifier with and without filter diode.
3. Design full wave rectifier with and without filter using diode.
4. Determine Input and output characteristic of BJT in CE configuration.
5. Design Darlington emitter follower circuit.
6. Design Voltage follower circuit using IC741.
7. Design inverting amplifier, non- inverting amplifier using ic741.
8. Design Summing amplifier and difference amplifier using IC741.
9. Design Zero crossing detector using IC 741.
10. Design Schmitt trigger using IC741.
11. Design Differentiator using IC741.
12. Design Integrator using IC741

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Electrical Drives Laboratory

EE607	PCC	**Electrical Drives Laboratory**	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2hr/week	CA-I:15 Marks CA-II: 15 Marks End Semester Exam: 20 Marks

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

CO1	Examine control techniques of AC motor drives.
CO2	Examine control techniques of DC motor drives.
CO3	Examine the performance of AC & DC drives using simulation tool.

List of Experiments:

1. To study speed control of single phase induction motor using VFD.
2. Speed control of three phase slip-ring motor using static scherbius drive
3. To perform speed control of separately excited dc motor using chopper.
4. Closed loop and open loop speed control of dc motor.
5. To perform Micro controller based speed control of 3 phase induction motor by stator voltage control.
6. Controlled Converter fed stepper motor drive.
7. Simulation of 3 phase induction motor drives.
8. Simulation of DC-DC converter drives.
9. Simulation of Stepper motor drives.

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Mega Project Phase-I (Seminar)

EE608	PCC	Mega Project Phase-I (Seminar)	0-0-4	2 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 4hr/week	CA-I:25 Marks CA-II: 25 Marks End Semester Exam: 50 Marks

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

CO1	Identify the problem statement.
CO2	Decide the methodology of proposed work.
CO3	Plan the project work in specified time frame.
CO4	Compose the progress report.

The project work should encompass the hardware and engineering computation software such as MATLAB, PSCAD, ETAP etc. techniques/tools introduced in the concerned subjects and should prove to be useful for the UG program in the relevant field with moderate to high complexity. The assessment shall consist of a detailed report for chosen topic and output of final working proposed. Report shall summarize the literature survey, spell out the scope of work, methodology and results. End Semester Examination shall be based on work carried out by the student.

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Field Training / Industrial Training

EE408	PROJ	Field training /Industrial training	0-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: -- Tutorial: -- Practical: --	CA1: 25 Marks CA2: 25 Marks

Course Outcomes: Students will be able to

CO1	Examine actual working environment
CO2	Demonstrate the use, interpretation and application of an appropriate engineering standard in a specific situation.
CO3	Identify sources of hazards, and assess/identify appropriate health & safety measures.
CO4	Summarize technical documents and give presentations related to the work completed

Instruction:

Students are expected to undergo industrial training for at least four weeks after III semester. Training session shall be guided and certified by qualified engineer / industry expert. Students should prepare detailed report on activities carried out during training. The evaluation shall be based on report and power point presentation.

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Aptitude Skills IV

(Numerical Ability)

HSMC	HMS07	Aptitude Skills- IV	1-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: 1hr Tutorial: NA Practical: NA	Continuous Assessment-I:25 Continuous Assessment-II:25

Pre-Requisites: Aptitude Skills-I/II

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

CO1	Solve the problems on system of equation
CO2	Solve the problems on seating arrangement
CO3	Solve the logical reasoning problems
CO4	Solve the critical analysis problems
CO5	Solve the problems of Data interpretation
CO6	Solve the problems permutations and combinations

Course Contents:

Unit I: System of equations quadratic equations, Surds and indices, solution of equations, Ages	**[2]**
Unit II: Seating Arrangements Linear seating Arrangement, Circular seating arrangement, Complex seating arrangement,	**[2]**
Unit III: Logical Reasoning Numerical based on sense of direction, Blood relations, Odd man Out	**[2]**
Unit IV: Critical analysis Clocks and Calendar based problems, Cryptarithmetic, heights and distance.	**[2]**
Unit V: Data Interpretation	**[2]**

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Table form, Bar form, Line for Pi chart form	
Unit VI: Permutation and combination Permutation and combinations	**[2]**
Text Books: 1. RS Aggarwal, " Quantitative Aptitude for Competitive Examinations ", S. Chand Publisher; 2016 edition. 2. Quantitative Aptitude for CAT TMH Publications 3. Vedic Maths Made Easy By Dhaval Bhatiya Jaico Publication House.	

Aptitude Skills IV

(Verbal Ability)

HSMC	HMS07	Aptitude Skills- IV	1-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: 1hr Tutorial: NA Practical: NA	Continuous Assessment-I:25 Continuous Assessment-II:25

Pre-Requisites: Aptitude Skills-I/II

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

CO1	Solve the questions on ordering of words & Parts of Speech
CO2	Organize contents of Business Communications such as CV, emails and letters.
CO3	Solve the questions based on jumbled paragraphs and reading comprehension.
CO4	Solve the questions on spotting error and sentence correction.
CO5	Summarize proceedings of any event or conference.
CO6	Discuss about current and critical issues during group discussion.

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Course Contents:

Unit I Parts of Speech, Punctuation Word Family (Using the same word as different Parts of Speech)	[2]
Unit II Analogy, Letter Writing (Formal), E-Mail Writing, CV Writing	[2]
Unit III Reading Comprehension, Paragraph Jumbles	[2]
Unit IV Spotting Errors (in different parts of sentence), Subject-Verb Agreement Sentence Correction, Sentence Completion	[2]
Unit V One Word Substitution, Narrating Events/Reports, Summary/Precis Writing	[2]
Unit VI Dialogue writing Group Discussion, Interview Skills (Using formal notations & gestures etc.)	[2]

Text Books:

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S. Aggarwal, S Chand Publishing; Revised edition (15 March 2017)

Reference Books:

1. Rao and ,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017.
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press; Second edition

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Language Skills - IV

HSMC	HMS08	Language Skill- IV	0-0-2	1Credit

Teaching Scheme:	Examination Scheme:
Lecture: NA Practical: 2 hrs/week	Continuous Assessment-1: 25 Continuous Assessment-2: 25

Pre-Requisites: Language Skill III

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

CO1	Make use of Function in Python Programming.
CO2	Make use of Python collections.
CO3	Make use of classes and its objects in python.
CO4	Make use of file and it's handling functions.

Course Contents

Unit I: Function Why we Need Function ,Categories of Functions-Predefined ,User-define , Parts of Functions Arguments, Return Value ,Definition of Function ,Function Calling ,Lambda(Introduction)	**[6]**
Unit II: Python Collections List, tuple, set, dictionary—-> constructor, check, change , remove item ,list comprehension , Sort ,loop through ,joining	**[6]**
Unit III: Class and Object OOP Characteristics , creating class ,_init_() method, creating Object , accessing methods andvariables of class ,constructor and destructor ,inheritance ,super(),function overloading	**[6]**
Unit IV: File handling Path & Directory Settings-Absolute, Relative, File Modes (r,w,a,etc) , Open & Close file Reading File using Python--Read Line By Line readline() function,Read Word,Read character(offset),Writing Text File using Python--Write Mode,Append Mode, Exception handling	**[6]**
Text Books 1. Python Projects (Author: Laura Cassell, Alan Gauld) Wrox publication	

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2. Murach's Python Programming. Author.:Michael Urban, Joel Murach, murach's Publication. 3. Fundamentals of Python (First Program) Cengage MINDTAP Publication 2nd Edition.Author: K.A. Kambert.	

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