ACE
Engineering College

Ankushapur(V), Ghatkesar(M), R.R.Dist - 501 301

(An Autonomous Institution)

B.TECH. THIRD YEAR DEGREE COURSE

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE

(R20 Regulation)

III Year				I Semester			
S.No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
1	PCC	EE501PC	Power Electronics	3	1	0	4
2	PCC	EE502PC	Power System-II	3	1	0	4
3	PCC	EE503PC	Electrical Measurements And Instrumentation	3	1	0	4
4	PEC		Professional Elective-I	3	0	0	3
5	HSMC	SM504MS	Business Economics and Financial Analysis	3	0	0	3
6	PCC	EE505PC	Power System Lab-II	0	0	2	1
7	PCC	EE506PC	Power Electronics Lab	0	0	2	1
8	PCC	EE507PC	Electrical Measurements andInstrumentation Lab	0	0	2	1
9	HSMC	EN508HS	Advanced English Communication skills Lab	0	0	2	1
10	MC	MC509	Intellectual Property Rights	3	0	0	0
11	MC	MC511	Artificial Intelligence	3	0	0	0
Total				**21**	**3**	**8**	**22**

III Year				II Semester			
S. No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
1	ESC	EE601PC	Digital Signal Processing	3	0	0	3
2	ESC	EE602PC	Microprocessors and Microcontrollers	3	0	0	3
3	PCC	EE603PC	Power System Protection	3	1	0	4
4	PCC	EE604PC	Power System Operation and Control	3	0	0	3
5	PEC		Professional Elective-II	3	0	0	3
6	OEC	EC600OE	Open Elective-I	3	0	0	3
7	PCC	EE605PC	Electrical Systems Simulation Lab	0	0	2	1
8	ESC	EE606PC	Microprocessors and Microcontrollers Lab	0	0	2	1
9	ESC	EE607PC	Digital Signal Processing Lab	0	0	2	1
10	MC	MC610	Cyber Security	3	0	0	0
Total				**21**	**1**	**6**	**22**

Note: *MC = Satisfactory/Unsatisfactory

ACE
Engineering College

Ankushapur(V), Ghatkesar(M), R.R.Dist - 501 301

(An Autonomous Institution)

B.TECH. FOURTH YEAR DEGREE COURSE

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE

(R20 Regulation)

IV Year				I Semester			
S. No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
01	PCC	EE701PC	Power Semiconductor Drives	2	0	0	2
02	HSMC	SM702MS	Fundamentals of Management for Engineers	3	0	0	3
03	PEC		Professional Elective-III	3	0	0	3
04	PEC		Professional Elective-IV	3	0	0	3
05	OEC		Open Elective-II	3	0	0	3
06	PCC	EE703PC	Electrical and Electronics Design Lab	0	0	2	1
07	PROJ	EE704PC	Project Phase-I	0	0	6	3
08	PROJ	EE705PC	Industry Oriented Mini Project	0	0	0	2
09	PROJ	EE706PC	Technical Seminar	0	0	2	1
10	MC	MC707EC	Introduction to ARDUINO	0	0	2	0
Total				**14**	**0**	**12**	**21**

NOTE: Industry Oriented Mini Project is to be carried out during the summer vacation between 6th and 7th semesters. Students should submit report of Industrial Oriented Mini Project for evaluation.

IV Year				II Semester			
S.No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
1	OEC		Open Elective-III	3	0	0	3
2	PEC		Professional Elective-V	3	0	0	3
3	PEC		Professional Elective-VI	3	0	0	3
4	PROJ	EE801PC	Project Phase-II	0	0	14	7
Total				9	0	14	16

***Open Elective – Students should take Open Electives from List of Open Electives Offered by Other Departments/Branches Only.**

PROFESSIONAL ELECTIVE-I

EE511PE	Computer Architecture
EE512PE	High Voltage Engineering
EE513PE	Special Electrical Machines
EE514PE	Linear Systems Analysis

PROFESSIONAL ELECTIVE-II

EE611PE	Optimization Techniques
EE612PE	Wind and Solar Energy Systems
EE613PE	Digital Control Systems
EE614PE	VLSI Design

PROFESSIONAL ELECTIVE-III

EE711PE	Flexible AC Transmission Systems
EE712PE	Power System De-Regulation
EE713PE	Computer Methods in power system
EE714PE	Power System Automation

PROFESSIONAL ELECTIVE-IV

EE721PE	HVDC Transmission
EE722PE	Power Quality
EE723PE	Advanced Control System
EE724PE	Electrical Machine Design

PROFESSIONAL ELECTIVE-V

EE811PE	EHV AC Transmission Systems
EE812PE	Artificial Intelligent Techniques for Electrical Systems
EE813PE	Advanced Power Electronics
EE814PE	Smart Electric Grid

PROFESSIONAL ELECTIVE-VI

EE821PE	Utilization of Electric Power
EE822PE	Hybrid Electric Vehicles
EE823PE	Control Systems Design
EE824PE	Reliability Engineering and Applications to Power systems

***Open Elective – Students should take Open Electives from List of Open Electives Offered by Other Departments/Branches Only. These are the list of open electives offered by our branch to other branches**

Open Elective-I

EE600OE	Renewable Energy Sources
EE601OE	Reliability Engineering

Open Elective-II

EE700OE	Estimation and Costing of Electrical systems
EE701OE	Engineering Optimization

Open Elective-III

EE800OE	Energy Storage System
EE801OE	Energy Management and Audit

EE501PC: POWER ELECTRONICS

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE501PC	PCC	3	1	0	4	30	70	100

Prerequisite: Analog Electronics(EE303PC), Digital Electronics (EE403PC)

Course Objectives:

1. To analyze the power electronic circuits.
2. To understand the principle of operation of different power conversion circuits.
3. To design suitable power converter for efficient control of power.
4. To design suitable power converter for efficient transmission and utilization of power in power system applications.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand operation of different power electronics devices.
2. Explain workings of phase-controlled rectifier circuits.
3. Examine the operation of DC-DC converter
4. Compare different modes of operation of inverters
5. Judge the performance of ac voltage controller

UNIT: I	POWER SWITCHING DEVICES

Concept of power electronics, scope and applications, types of power converters; Power semiconductor switches and their V-I characteristics - Power Diodes, Power BJT, SCR, Power MOSFET, Power IGBT; Thyristor ratings and protection, methods of SCR commutation, UJT as a trigger source, gate drive circuits for BJT and MOSFETs

UNIT: II	AC-DC CONVERTERS

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 load and source inductances, General idea of gating circuits, Single phase and Three phase dual converters.

UNIT: III	DC-DC CONVERTERS

Introduction, elementary chopper with an active switch and diode, concepts of duty ratio, average inductor voltage, average capacitor current. Buck converter - Power circuit, analysis and waveforms at steady state, duty ratio control of output voltage. Boost converter - Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Buck-Boost converter - Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Unit: IV	DC-AC CONVERTERS

: Introduction, principle of operation, performance parameters, single phase bridge inverters with R, RL loads, 3-phase bridge inverters - 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.

UNIT: V	AC-AC CONVERTERS

Phase Controller (AC Voltage Regulator)-Introduction, principle of operation of single-phase voltage controllers for R, R-L loads and its applications. Cyclo-converter-Principle of operation of single phase cyclo-converters, relevant waveforms, circulating current mode of operation, Advantages and disadvantages.

TEXT BOOKS:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 4th Edition, 2014.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 3rdEdition , 2007.

REFERENCE BOOKS:

1. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", 4th Edition Springer Science & Business Media, 2007.
2. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105066/
2. https://nptel.ac.in/courses/108/101/108101126/
3. https://nptel.ac.in/courses/108/101/108101038/

EE502PC: POWER SYSTEM – II

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE502PC	PCC	3	1	0	4	30	70	100

Prerequisite: Power System-I(EE405PC)

Course Objectives:

1. To analyze the performance of transmission lines
2. To understand the voltage control and compensation methods
3. To understand the per unit representation of power systems
4. To understand the per unit representation of power systems

Course Outcomes: Upon completing this course, the student will be able to

1. Analyze transmission line performance
2. Apply load compensation techniques to control reactive power
3. Understand the application of per unit quantities
4. Design over voltage protection and insulation coordination
5. Determine the fault currents for symmetrical and unbalanced faults

UNIT: I	PERFORMANCE OF LINES

Representation of lines, short transmission lines, medium length lines, nominal T and PI- representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram.

UNIT: II	VOLTAGE CONTROL

Introduction – methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers. Compensation In Power Systems: Introduction - Concepts of Load compensation – Load ability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

UNIT: III	PER UNIT REPRESENTATION OF POWER SYSTEMS

The one-line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system. Travelling Waves on Transmission Lines: Production of travelling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

UNIT: IV	OVERVOLTAGE PROTECTION AND INSULATION COORDINATION

Over voltage due to arcing ground and Peterson coil, lightning, horn gaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves.

UNIT: V	SYMMETRICAL COMPONENTS AND FAULT CALCULATIONS

Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus.

TEXT BOOKS:

1. John J. Grainger & W.D. Stevenson, “Power System Analysis”, Mc Graw Hill International, 2017.
2. C.L. Wadhwa, “Electrical Power Systems” – New Age International Pub. Co. Third Edition, 2016.

REFERENCE BOOKS:

1. D. P. Kothari;I. J. Nagrath, “Power System Engineering”, McGraw-Hill; Third edition, 26 April 2019
2. A.N Kani, “Power System Analysis”, CBS; Reprint edition, 2020
3. D.P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, Tata Mc Graw Hill Pub. Co., New Delhi, Fourth edition, 2011

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105104/
2. https://nptel.ac.in/courses/108/105/108105067/

EE503PC: ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE503PC	PCC	3	1	0	4	30	70	100

Prerequisite: Basic Electrical Engineering (EE103ES), AnalogElectronics (EE303PC), ElectricalCircuits (EE302PC) & Electro Magnetic Fields (EE305PC).

Course Objectives:

1. To introduce the basic principles of all measuring instruments
2. To understand the constructional details and principle of operation of basic analog and digital measuring instruments.
3. To deal with the measurement of voltage, current, Power factor, power, energy and magnetic measurements.
4. To understand the basic concepts of smart and digital metering.

Course Outcomes: Upon completing this course, the student will be able to

1. Illustrate different types of measuring instruments, their construction, operation and characteristics
2. Identify the instruments suitable for typical measurements
3. Apply the knowledge about transducers and instrument transformers to use them effectively.
4. Analyze smart and digital metering for industrial applications.
5. Examine the operation of potentiometer for calibration of Instruments.

UNIT: I INTRODUCTION TO MEASURING INSTRUMENTS

Classification – deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type instruments – expression for the deflecting torque and control torque – Errors and compensations, extension of range using shunts and series resistance. Electrostatic Voltmeters electrometer type and attracted disc type – extension of range of E.S. Voltmeters.

UNIT: II POTENTIOMETERS & INSTRUMENT TRANSFORMERS

Principle and operation of D.C. Crompton"s potentiometer – standardization – Measurement of unknown resistance, current, voltage. A.C. Potentiometers: polar and coordinate type"s standardization – applications. CT and PT – Ratio and phase angle errors.

UNIT: III MEASUREMENT OF POWER & ENERGY

Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced and unbalanced systems. Single phase induction type energy meter – driving and braking torques – errors and compensations – testing by phantom loading using R.S.S. meter. Three phase energy meter – tri-vector meter, maximum demand meters.

UNIT: IV DC & AC BRIDGES

Method of measuring low, medium and high resistance – sensitivity of Wheat-stone"s bridge – Carey Foster"s bridge, Kelvin"s double bridge for measuring low resistance, measurement of high resistance – loss of charge method. Measurement of inductance- Maxwell"s bridge, Hay"s bridge, Anderson"s bridge - Owen"s bridge. Measurement of capacitance and loss angle –Desaunty"s Bridge - Wien"s bridge – Schering Bridge.

UNIT: V TRANSDUCERS

Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermocouples, Piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes.

Introduction to Smart and Digital Metering: Digital Multi-meter, True RMS meters, Clamp-on meters, Digital Storage Oscilloscope

TEXT BOOKS:

1. G. K. Banerjee, "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition, 2016
2. S. C. Bhargava, "Electrical Measuring Instruments and Measurements", BS Publications, 2013.

REFERENCE BOOKS:

1. A. K. Sawhney, "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co. Publications, 2021.
2. R. K. Rajput, "Electrical & Electronic Measurement & Instrumentation", S. Chand and Company Ltd., 2016.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee44/
3. https://www.classcentral.com/course/swayam-electrical-measurement-and-electronic-instruments-14032

EE511PE: COMPUTER ARCHITECTURE
(Professional Elective-I)

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE511PE	PEC	3	0	0	3	30	70	100

Prerequisite: Digital Electronics(EE403PC)

Course Objectives:

1. To understand basic components of computers.
2. To understand the architecture of 8086 processor.
3. To understand the instruction sets, instruction formats and various addressing modes of 8086.
4. To understand the representation of data at the machine level and how computations are Performed at machine level.
5. To understand the memory organization and I/O organization.
6. To understand the parallelism both in terms of single and multiple processors.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the concepts of microprocessors, their principles and practices.
2. Write efficient programs in assembly language of the 8086 family of microprocessors.
3. Organize a modern computer system and be able to relate it to real examples.
4. Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
5. Implement embedded applications using ATOM processor.

UNIT: I	INTRODUCTION TO COMPUTER ORGANIZATION

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating-point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

UNIT: II	MEMORY AND INPUT – OUTPUT ORGANIZATION

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

Input – Output Organization Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

UNIT: III	16 AND 32 MICROPROCESSORS

80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86

UNIT: IV	PIPELINING

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP,Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on

instruction set.

UNIT: V	DIFFERENT ARCHITECTURES

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

TEXT BOOKS:

1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.

REFERENCE BOOKS:

1. 1. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
2. W. Stallings, "Computer organization", PHI, 1987.
3. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.
4. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.
5. Y. C. Lieu and G. A. Gibson, "Microcomputer Systems: The 8086/8088 Family", Prentice Hall India, 1986.
6. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
7. B. Govindarajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
8. P. Able, "8086 Assembly Language Programming", Prentice Hall India.

EE512PE: HIGH VOLTAGE ENGINEERING
(Professional Elective-I)

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE512PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Systems – I (EE405PC), Electro Magnetic Fields (EE305PC)

Course Objectives:

7. To analyze breakdown phenomenon gaseous, liquids and solid dielectrics.
8. To inform about generation and measurement of high voltage and current.
9. To understand lightning surges and switching over-voltages.
10. To introduce high voltage testing methods.

Course Outcomes: Upon completing this course, the student will be able to

6. Understand breakdown incident in solid, liquid and gaseous insulating materials.
7. Differentiate the generation and measurement of D. C., A.C., & Impulse voltages.
8. Develop tests on H. V. equipment and insulating materials, as per the standards.
9. Analyze the generation of over-voltages in a power system.
10. Describe protection of over-voltages.

UNIT: I	FUNDAMENTALS OF INSULATING MATERIALS

Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend"s theory, Streamer mechanism, Corona discharge. Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

UNIT: II	GENERATION OF HIGH VOLTAGES

Generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

UNIT: III	MEASUREMENTS OF HIGH VOLTAGES AND CURRENTS

Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillo-graphs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

UNIT: IV	LIGHTNING AND SWITCHING OVER-VOLTAGES

Charge formation in clouds, stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, and Surge modifiers.

UNIT: V	HIGH VOLTAGE TESTING OF ELECTRICAL COMPONENTS

Various standards for HV Testing of electrical apparatus, IS, IEC standards, testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

TEXT BOOKS:

3. "M. S. Naidu","V.Kamaraju", High Voltage Engineering, McGraw Hill Education, 2020 6th Edition
4. "C. L. Wadhwa", High Voltage Engineering, New Age Science, 2010

REFERENCE BOOKS:

9. "John Kuffel", High Voltage Engineering Fundamentals, Elsevier, 3rd Ed2012
10. "E. Kuffel", "W. S. Zaengl","J.Kuffel", "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
11. "R. Arora","W.Mosch", "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104048/
2. https://ietresearch.onlinelibrary.wiley.com/journal/23977264

EE513PE: SPECIAL ELECTRICAL MACHINES

(Professional Elective-I)

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE513PE	PEC	3	0	0	3	30	70	100

Prerequisite: Electrical Machines-I(EE304PC), Electrical Machines-II(EE402PC)

Course Objectives:

1. To learnthe construction and operation of PMDC motor
2. To understand working and application of BLDC motor
3. To illustrate the application of special machines
4. To understand working principle of stepper motor

Course Outcomes: Upon the completion of this subject, the student will be able

1. Apply the working principle of PMDC motor.
2. Analyze the performance of a BLDC motor.
3. Derive emf equation of various special machines.
4. Develop controlling technique to PMSM motor.
5. Analyze the operation of stepper motor.

UNIT: I	SPECIAL PURPOSE DC MOTORS

Permanent magnet DC Motor- PMDC Motors-construction-Principle of operation- characteristics and applications

Brushless DC motor- BLDC Motors-construction-Principle of operation- characteristics and applications

UNIT: II	PERMANENT MAGNET AC MOTORS

Permanent magnet Synchronous Motor- PMSM Motors-construction-Principle of operation-characteristics, applications and control techniques.

UNIT: III	SWITCHED RELUCTANCE MOTOR

Introduction-construction-operation-application – improvements in the design of conventional reluctance motors- Some distinctive differences between SR and conventional reluctance motors-principle of operation of SRM

UNIT: IV	STEPPER MOTORS

Stepper Motors: Introduction-synchronous inductor (or hybrid stepper motor), Hybrid stepping motor, construction, principles of operation, Energization with two phase at a timeessential conditions for the satisfactory operation of a 2-phase hybrid step motor- very slow speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors-an open-loop controller for a 2-phase stepping motor.

UNIT: V	SYNCHRONOUS RELUCTANCE MOTOR &LINER INDUCTION MOTORS

Synchronous Reluctance Motor Construction, Working, Phasor Diagram, Torque Equation, Control - Direct Axis Current Control, Fast Torque Response Control, Advantages

Linear induction motors (LIM) Construction – Principle of operation – Double sided LIM from

rotating type Induction Motor – Schematic of LIM drive for traction – Development of one-sided LIM with back iron-equivalent circuit of LIM.

TEXT BOOKS:

1. K. Venkataratnam, Special electrical machines, university press, 2009
2. R. K. Rajput - Electrical machines, Laxmi Publications, 5th Edition 2016

REFERENCE BOOKS:

1. V.V. Athani - Stepper motor: Fundamentals, Applications and Design, New age International publishers, 1997
2. "E. G. Janardanan", Special electrical machines-PHI 2014.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/102/108102156/

EE514PE: LINEAR SYSTEMS ANALYSIS

(Professional Elective I)

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE514PE	PEC	3	0	0	3	30	70	100

Prerequisite: Mathematics – II (MA201BS), Electrical Circuits**(**EE302PC**)**

Course Objectives:

1. To develop ability to analyze linear systems and signals
2. To develop critical understanding of mathematical methods to analyze linear systems and signals
3. To understand about Fourier Series and Fourier Transform representation
4. To understand, Laplace transform and its applications

Course Outcomes: Upon completing this course, the student will be able to

1. Understand State Variable Analysis
2. Apply mathematical modeling tools to represent linear systems
3. Employmathematical modeling tools to analyze linear systems
4. Understand the concepts of Fourier Series, Fourier Transform representation, Laplace transform
5. Know about sampling theorem.

UNIT: I	STATE VARIABLE ANALYSIS

Choice of state variables in Electrical Networks-Formulation of state equations for Electrical networks Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.

UNIT: II	FOURIER SERIES AND FOURIER TRANSFORM REPRESENTATION AND APPLICATIONS

Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function ,Properties of Fourier Transform, Parseval"s theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.

Introduction, Effective value, and average values of non sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.

UNIT: III	LAPLACE TRANSFORM APPLICATIONS AND NETWORK SYNTHESIS

Application of Laplace transform Methods of Analysis – Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications Testing of Polynomials: Elements of realisability - Hurwitz polynomials-positive real functions-Properties-Testing-Sturm"s Test, examples.

Synthesis of one port LC networks-Foster and Cauermethods-Synthesis of RL and RC one port networks-Foster and Cauer methods

UNIT: IV	SAMPLING

Sampling theorem – Graphical and Analytical proof for Band Limited Signal impulse sampling, natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, introduction to Band Pass sampling, Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Power density spectrum, Relation between auto correlation function and Energy / Power spectral density function.

UNIT: V	Z-TRANSFORMS

Fundamental difference between continuous and discrete time signals, discrete time complex, exponential and sinusoidal signals, periodicity of discrete time complex exponential, concept of Z Transform of a discrete sequence. Distinction between Laplace, Fourier, and Z-Transforms. Region of convergence in Z-Transforms, constraints on ROC for various classes of signals, Inverse Z-Transform properties of Z-Transforms.

TEXT BOOKS:

1. "B. P. Lathi", "Signals, Systems and Communications", BS Publications 2020.
2. "Umesh Sinha" "Network Analysis and Synthesis", Satya Prakashan Publications, 2013.

REFERENCE BOOKS:

1. "A. N. Tripathi", "Linear System Analysis", New Age International, 2nd Edition 2010.
2. "D. Roy Chowdhary", "Network and Systems", New Age International, 2013.
3. "Gopal G Bhise, Prem R. Chadha", Engineering Network Analysis and Filter Design, Umesh Publications 2012.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106162/
2. https://onlinecourses.nptel.ac.in/noc19_ee43

SM504MS: BUSINESS ECONOMICS AND FINANCIAL ANALYSIS

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
SM504MS	HSMC	3	0	0	3	30	70	100

Prerequisite: Nil

Course Objectives:

1. To learn the basic business types, impact of the economy on Business and Firms specifically.
2. To analyze the Business from the Financial Perspective.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the various Forms of Business and the impact of economic variables on the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt.
2. The Students can study the firm's financial position by analysing the Financial Statements of a Company.

Unit: I	INTRODUCTION TO BUSINESS AND ECONOMICS

Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance. Economics: Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply and Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

Unit: II	DEMAND AND SUPPLY ANALYSIS

Elasticity of Demand: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting. Supply Analysis: Determinants of Supply, Supply Function and Law of Supply.

Unit: III	PRODUCTION, COST, MARKET STRUCTURES AND PRICING

Production, Cost, Market Structures & Pricing Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions. Cost analysis: Types of Costs, Short run and Long run Cost Functions. Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition. Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis.

Unit: IV	FINANCIAL ACCOUNTING:

Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

UNIT-V	FINANCIAL ANALYSIS THROUGH RATIOS

Concept of Ratio Analysis, Importance, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios – Analysis and Interpretation (simple problems).

TEXT BOOKS:

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata Mc –Graw Hill, 2011.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e,Tata Mc Graw Hill Education Pvt. Ltd. 2012.

REFERENCE BOOKS:

1. Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013

WEB REFERENCES:

1. https:// www.slideshare.net/glory1988/managerial-economics-and- financial analysis.
2. https:// thenthata.web4kurd.net/mypdf/managerial-economics-and- financial analysis.

EE505PC: POWER SYSTEM LAB-II

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE505PC	PCC	0	0	2	1	30	70	100

Prerequisite: Power System-I(EE405PC),Power System-II(EE502PC), Electrical Machines-I(EE304PC), Electrical Machines-II(EE402PC),

Course Objectives:

1. To find sequence impedances of 3-Φ synchronous machine
2. To find sequence impedances of 3-Φ Transformer
3. To find ABCD parameters of a transmission line
4. To perform fault analysis on Transmission line.

Course Outcomes: After completion of this lab, the student will be able to

1. Analyze IDMT over current relay
2. Understand differential protection of single-phase transformer
3. Analyze ABCD constants of a long transmission line.
4. Determine characteristics of under voltage and over voltage
5. Simulate shunt capacitor for under voltage control using MATLAB

List of Experiments:

1. Characteristics of IDMT Over-Current Relay
2. Differential protection of 1-Φ transformer
3. Characteristics of Micro Processor based Over Voltage/Under Voltage relay
4. A, B, C, D constants of a Long Transmission line
5. Finding the sequence impedances of 3-Φ synchronous machine.
6. Finding the sequence impedances of 3-Φ Transformer.
7. Simulation of LG, LL, LLG and LLL faults on a simple power system using PSCAD/MATLAB
8. Simulation of load compensation
9. Determination of Sequence components (Positive, Negative and Zero) of an Alternator
10. Determine ABCD parameters of short, medium and long Transmission lines using MATLAB.
11. Determine Characteristics of under voltage and over voltage using PSCAD/MATLAB
12. Simulation of a shunt capacitor for under voltage control using MATLAB.

WEB REFERENCES:

1. https://vp-dei.vlabs.ac.in/Dreamweaver/list.html

EE506PC: POWER ELECTRONICS LAB

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE506PC	PCC	0	0	2	1	30	70	100

Prerequisite : Power Electronics(EE501PC)

Course Objectives:

1. Apply the concepts of power electronic converters for efficient conversion/control of power from source to load.
2. Design the power converter with suitable switches meeting a specific load requirement.
3. To make the students to design triggering circuits of SCR.
4. To perform the experiments on various converters.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the operating principles of various power electronic converters.
2. Analyze the characteristics of MOSFET, IGBT, SCR and SCR firing CKTs,
3. Develop the simulation model power converters.
4. Apply different commutation technique to turn off SCR
5. Examine output of inverter for different types of loads

List of Experiments:

1. Study of Characteristics of SCR, MOSFET & IGBT,
2. Gate firing circuits for SCR's
3. Single Phase AC Voltage Controller with R and RL Loads
4. Single Phase half controlled &fully controlled bridge converter with R and RL loads
5. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
6. Single Phase Cyclo-converter with R and RL loads
7. Single Phase series& parallel inverter with R and RL loads
8. Single Phase Bridge inverter with R and RL loads.
9. DC Jones chopper with R and RL Loads
10. Single Phase dual converter with RL loads

Following experiment are to be done by using suitable software.

11. (a) Simulation of single-phase Half wave converter using R and RL loads
    (b) Simulation of single-phase full converter using R, RL and RLE loads
    (c) Simulation of single-phase Semi converter using R, RL and RLE loads
12. (a) Simulation of Single-phase AC voltage controller using R and RL loads
    (b)Simulation of Single phase Cyclo-converter with R and RL-loads
13. Simulation of Buck chopper
14. Simulation of single-phase Inverter with PWM control
15. Simulation of three phase fully controlled converter with R and RL loads, with and without Freewheeling diode. Observation of waveforms for Continuous and Discontinuous modes of Operation.
16. Study of PWM techniques

Virtual Lab

http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php

EE507PC: ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE507PC	PCC	0	0	2	1	30	70	100

Prerequisite: Electrical Measurements and Instrumentation (EE503PC)

Course Objectives:

1. To calibrate LPF Watt Meter, energy meter, P. F Meter using electro dynamo meter type instrument as the standard instrument
2. To determine unknown inductance, resistance, capacitance by performing experiments on D.C Bridges & A. C Bridges
3. To determine three phase active & reactive powers using single wattmeter method practically
4. To determine the ratio and phase angle errors of current transformer and potential transformer.

Course Outcomes: Upon completing this course, the student will be able to

1. To select instruments
2. Analyze anyelectrical instrument
3. Find the accuracy of any instrument by performing experiment.
4. Calibrate PMMC instrument using D.C potentiometer.
5. Estimate the Strength of Dielectric oil

List of Experiments:

1. Calibration and Testing of single-phase energy Meter.
2. Calibration of dynamometer power factor meter.
3. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.
4. Kelvin"s double Bridge – Measurement of resistance – Determination of Tolerance.
5. Dielectric oil testing using H.T. testing Kit.
6. Schering Bridge & Anderson Bridge.
7. Measurement of 3 - Phase reactive power with single-phase wattmeter.
8. Measurement of displacement with the help of LVDT.
9. Calibration LPF wattmeter – by Phantom testing.
10. Measurement of 3-phase power with single watt meter and two CTs.
11. C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.
12. PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT
13. Resistance strain gauge – strain measurements and Calibration.
14. Transformer turns ratio measurement using AC bridges.
15. Measurement of % ratio error and phase angle of given CT by comparison.

WEB REFERENCES:

1. http://vlabs.iitkgp.ernet.in/asnm/exp10/index.html
2. http://vlabs.iitkgp.ernet.in/asnm/exp23/index.html
3. http://vlabs.iitkgp.ernet.in/asnm/exp21/index.html
4. https://vp-dei.vlabs.ac.in/Dreamweaver/exp4.html
5. http://vlabs.iitkgp.ernet.in/asnm/exp7/index.html

EN508HS: ADVANCED ENGLISH COMMUNICATION SKILLS LAB

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EN508HS	HSMC	0	0	2	1	30	70	100

Prerequisite: Knowledge of functional English, basics in grammar, understanding of LSRW skills

Course Objectives:

1. To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
2. Further, they would be required to communicate their ideas relevantly and coherently in writing.
3. To prepare all the students for their placements.

Course Outcomes: Upon completing this course, the student will be able to

1. Better understanding of nuances of English language through audio- visual experience and group activities
2. Neutralization of accent for intelligibility
3. Speaking skills with clarity and confidence which in turn enhances their employability skills

SYLLABUS

1. Activities on Fundamentals of Inter-personal Communication and Building Vocabulary - Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations & Discourse Skills- using visuals - Synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations & usage of vocabulary.

2. Activities on Reading Comprehension –General Vs Local comprehension, reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading& effective googling.

3. Activities on Writing Skills – Structure and presentation of different types of writing – letter writing/Resume writing/ e-correspondence/Technical report writing/ – planning for writing – improving one's writing.

4. Activities on Presentation Skills – Oral presentations (individual and group) through JAM sessions/seminars/PPTs and written presentations through posters/projects/reports/ emails/assignments etc.

5. Activities on Group Discussion and Interview Skills – Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and Mock Interviews.

MINIMUM REQUIREMENT:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics.

- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- P – IV Processor, Hard Disk – 80 GB, RAM–512 MB Minimum, Speed – 2.8 GHZ
- T. V, a digital stereo & Camcorder
- Headphones of High quality

SUGGESTED SOFTWARE: The software consisting of the prescribed topics elaborated above should be procured and used.

- Oxford Advanced Learner's Compass, 7th Edition
- DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
- Lingua TOEFL CBT Insider, by Dream tech
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)

TEXT BOOKS:

1. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2 nd Edition

2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

References:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and HemalathaNagarajan. Pearson 2007

2. Professional Communication by ArunaKoneru, McGraw Hill Education (India) Pvt. Ltd, 2016.

3. Technical Communication by Meenakshi Raman &Sangeeta Sharma, Oxford University Press 2009.

4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.

5. English Vocabulary in Use series, Cambridge University Press 2008.

6. Handbook for Technical Communication by David A. McMurrey& Joanne Buckley. 2012. Cengage Learning.

7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.

8. Job Hunting by ColmDownes, Cambridge University Press 2008.

9. English for Technical Communication for Engineering Students, AyshaVishwamohan, Tata Mc Graw-Hill 2009.

MC509: INTELLECTUAL PROPERTY RIGHTS

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
MC509	MC	3	0	0	0	100	0	100

UNIT: I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT: II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT: III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT: IV

Trade Secrets: Trade secret law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of Publicity, false advertising.

UNIT: V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

TEXT BOOKS & REFERENCE BOOKS:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

MC511: ARTIFICIAL INTELLIGENCE

B.TECH. III YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
MC511	MC	3	0	0	0	100	0	100

Prerequisite: Nil

Course Objectives:

1. To train the students to understand different types of AI agents, various AI search algorithms, fundamentals of knowledge representation, building of simple knowledge-based systems and to apply knowledge representation, reasoning. Study of Markov Models enable the student ready to step into applied AI.

UNIT: I

Introduction: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents Basic Search Strategies: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), Constraint Satisfaction (Backtracking, Local Search)

UNIT: II

Advanced Search: Constructing Search Trees, Stochastic Search, A* Search Implementation, Minimax Search, Alpha-Beta Pruning Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem

UNIT: III

Advanced Knowledge Representation and Reasoning: Knowledge Representation Issues, Nonmonotonic Reasoning, Other Knowledge Representation Schemes Reasoning Under Uncertainty: Basic probability, Acting Under Uncertainty, Bayes' Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks

UNIT: IV

Learning: What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

UNIT: V

Expert Systems: Representing and Using Domain Knowledge, Shell, Explanation, Knowledge Acquisition.

TEXT BOOKS:

1. Russell, S. and Norvig, P, Artificial Intelligence: A Modern Approach, Third Edition, PrenticeHall, 2010.

REFERENCE BOOKS:

1. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivasankar B. Nair, The McGraw Hill publications, Third Edition, 2009.

2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.

EE601PC: DIGITAL SIGNAL PROCESSING

B.TECH. III YEAR II SEMESTER								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
EE601PC	**ESC**	3	0	0	3	30	70	100

Prerequisite: Nil

Course Objectives:

1. This gives the basics of Signals and Systems required for all Electrical Engineering related courses
2. To understand the behavior of signal in time and frequency domain
3. To understand the characteristics of LTI systems
4. This gives concepts of Signals and Systems and its analysis using different transform techniques.
5. To study the designs and structures of digital (IIR and FIR) filters and analyze and synthesize for a given specifications.

Course Outcomes: Upon completing this course, the student will be able to

1. Differentiate various signal functions.
2. Represent any arbitrary signal in time and frequency domain.
3. Understand the characteristics of linear time invariant systems.
4. Analyze the signals with different transform technique.
5. Design a digital filter for a given specification.

UNIT: I SIGNAL ANALYSIS, FOURIER SERIES, FOURIER TRANSFORMS

Classification of Signals and systems, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.

Fourier series: Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum.

Fourier Transforms: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function.

Frequency Domain Representation of Discrete Time Signals and Systems

UNIT: II SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS, SAMPLING THEOREM

Signal Transmission through Linear Systems:

Linear System, Impulse response, Response of a Linear System, Linear Time Invariant(LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI System, Filter characteristic of Linear System, Concept of convolution in Time domain and Frequency domain

Sampling theorem: Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing,

UNIT: III LAPLACE TRANSFORMS, Z–TRANSFORMS

Laplace Transforms: Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.

Z–Transforms: Concept of Z- Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.

UNIT: IV IIR DIGITAL FILTERS AND REALIZATION OF DIGITAL FILTERS

IIR Digital Filters: Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital Filters from Analog Filters, Step and Impulse Invariant Techniques, Bilinear Transformation Method, Spectral Transformations.

Realization of Digital Filters: Realization of Digital Filters – Direct, Canonic, Cascade and Parallel Forms.

UNIT: V	**FIR DIGITAL FILTERS**

FIR Digital Filters: Characteristics of FIR Digital Filters, Frequency Response. Design of FIR Filters: Fourier Method, Digital Filters using Window Techniques, Comparison of IIR & FIR filters.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, 2013, BSP.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2 Ed.
3. Discrete Time Signal Processing – A. V. Oppenheim and R.W. Schaffer, PHI, 2009
4. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.

REFERENCE BOOKS:

1. Signals and Systems – Simon Haykin and Van Veen, Wiley 2 Ed.,
2. Signals and Systems – A. Rama Krishna Rao, 2008, TMH
3. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.
4. Signals, Systems and Transforms - C. L. Philips, J.M.Parr and Eve A.Riskin, 3 Ed., 2004, PE.
5. Signals and Systems – K. Deergha Rao, Birkhauser, 2018.
6. Digital Signal Processing – Fundamentals and Applications – Li Tan, Elsevier, 2008
7. Fundamentals of Digital Signal Processing using MATLAB – Robert J. Schilling, Sandra L. Harris, Thomson, 2007
8. Digital Signal Processing – S. Salivahanan, A. Vallavaraj and C. Gnanapriya, TMH, 2009
9. Digital Signal Processing - A Practical approach, Emmanuel C. Ifeachor and Barrie W. Jervis, 2nd Edition, Pearson Education, 2009

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106151/
2. https://nptel.ac.in/courses/108/101/108101174/
3. https://nptel.ac.in/courses/117/101/117101055/

EE602PC: MICROPROCESSORS AND MICROCONTROLLERS

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE602PC	ESC	3	0	0	3	30	70	100

Prerequisite: Digital System Design, Computer Organization, Basics of VLSI, Basic Programming Knowledge

Course Objectives:

1. To develop an understanding of the functionality of microprocessors; Assembly language programming and interfacing techniques.
2. To provide knowledge on functionality of microcontrollers; Assembly language programming and interfacing techniques.
3. To develop an understanding of the operations and Programming of ARM Processor
4. To study the basic concepts of Advanced ARM processors (A, R, M profile) and their applications.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the 8086µp architecture, its operation and apply the knowledge of instruction set& assembler directives to write Programs using MASM.
2. Understand the 8051µc architecture, its operation and apply the knowledge of instruction setto design applications.
3. Apply the knowledge of 8051µc and Communication protocols to interface I/O devices.
4. Understand the ARM processor internal architecture; apply the knowledge of instruction set todesign applications.
5. Understand the ARM CORTEX and OMAP Processor architecture and architecture and theirapplications.

UNIT: I 8086 MICROPROCESSOR ARCHITECTURE & INSTRUCTION SET

8086 Architecture: 8086 Architecture-Functional diagram, Register Organization, Memory Segmentation, Programming Model, Memory addresses, Physical Memory Organization, Architecture of 8086, Signal descriptions of 8086, interrupts of 8086.

Instruction Set and Assembly Language Programming of 8086: Instruction formats, Addressing modes, Instruction Set, Assembler Directives, Macros, and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations.

UNIT: II 8051 MICROCONTROLLER ARCHITECTURE & REAL TIME CONTROL

Introduction to Microcontrollers: Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes and Instruction set of 8051.

8051 Real Time Control: Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Programming 8051 Timers and Counters

UNIT: III I/O, MEMORY & SERIAL BUS INTERFACE

I/O and Memory Interface: LCD, Keyboard, External Memory RAM, ROM Interface, ADC, DAC Interface to 8051.

Serial Communication and Bus Interface: Serial Communication Standards, Serial Data Transfer Scheme, On board Communication Interfaces-I2C Bus, SPI Bus, UART; External Communication Interfaces-RS232,USB.

UNIT: IV ARM ARCHITECTURE

ARM Processor fundamentals, ARM Architecture – Register, CPSR, Pipeline, exceptions and interrupts interrupt vector table, ARM instruction set – Data processing, Branch instructions, load store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution, Introduction to Thumb instructions.

UNIT: V	**ADVANCED ARM PROCESSORS**

Introduction to CORTEX Processor and its architecture, OMAP Processor and its Architecture.

TEXT BOOKS:

1. Advanced Microprocessors and Peripherals – A. K. Ray and K.M. Bhurchandani, MHE, 2ndEdition 2006.
2. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed.
3. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, ChrisWRIGHT, Elsevier, 2012

REFERENCE BOOKS:

1. Microprocessors and Interfacing, D. V. Hall, MGH, 2nd Edition 2006.
2. Introduction to Embedded Systems, Shibu K.V, MHE, 2009
3. The 8051Microcontrollers, Architecture and Programming and Applications -K.UmaRao, Andhe Pallavi, Pearson, 2009.

WEB REFERENCES:

1. https://www.arm.com/
2. https://www.intel.com/content/www/us/en/homepage.html
3. https://onlinecourses.nptel.ac.in/noc20_ee42/preview
4. https://ict.iitk.ac.in/courses/microprocessors-and-microcontrollers/
5. https://en.wikipedia.org/wiki/Microcontroller
6. https://nptel.ac.in/courses/108/103/108103157/
7. https://nptel.ac.in/courses/106/105/106105193/

EE603PC: POWER SYSTEM PROTECTION

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE603PC	PCC	3	1	0	4	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC)

Course Objectives:

2. To introduce all kinds of circuit breakers and relays
3. To explain the voltage control and compensation methods
4. To understand the phenomenon of Over Voltages and its classification
5. To study Microprocessor Based Relays

Course Outcomes: Upon completing this course, the student will be able to

1. Compare electromagnetic, static and microprocessor-based relays
2. Apply technology to protect power system components
3. Interpret relay settings of over current and distance relays
4. Evaluate quenching mechanisms used in air, oil and vacuum circuit breakers
5. Analyze the testing of circuit breakers

UNIT: I	PROTECTIVE RELAYS

Introduction, Need for power system protection, effects of faults, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology. Operating Principles and Relay Construction: Electromagnetic relays, thermal relays, static relays, microprocessor based protective relays.

UNIT: II	OVER-CURRENT PROTECTION DISTANCE PROTECTION

Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay. Distance Protection: Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, auto re-closing.

UNIT: III	PILOT RELAYING SCHEMES AC MACHINES AND BUS ZONE PROTECTION

Wire Pilot protection, Carrier current protection. AC Machines and Bus Zone Protection: Protection of Generators, Protection of transformers, Buszone protection, frame leakage protection.

UNIT: IV	STATIC RELAYS MICROPROCESSOR BASED RELAYS

Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, static over current relays, static directional relay, static differential relay, static distance relays, Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics. Microprocessor Based Relays: Advantages, over current relays, directional relays, distance relays.

UNIT: V	CIRCUIT BREAKERS FUSES

Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuit breakers. FUSES: Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination.

TEXT BOOKS:

1. "Badriram"," D.N. Vishwakarma", Power System Protection and Switchgear, McGraw Hill Education; 2nd edition, 2017
2. "Sunil S.Rao", Switchgear Protection And Power Systems", Khanna Publishers, 14th edition, 2019

REFERENCE BOOKS:

1. "U.A.Bakshi", "M.V.Bakshi",Switchgear and Protection, Technical Publications, 1st edition 2021
2. "J.B. Gupta", Fundamentals of Switchgear and Protection, S.K. Kataria& Sons; 2013 edition, 2013
3. "D.P. Kothari","I. J. Nagrath", Modern Power System Analysis - Tata Mc Graw Hill Pub. Co., New Delhi, Fourth edition, 2011

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://nptel.ac.in/courses/108/105/108105167/

EE604PC: POWER SYSTEM OPERATION AND CONTROL

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE604PC	PCC	3	0	0	3	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC)

Course Objectives:

1. To understand real power control and operation
2. To know the importance of frequency control
3. To analyze different methods to control reactive power
4. To analyze different methods to control reactive power

Course Outcomes: Upon completing this course, the student will be able to

1. Analyze the optimal scheduling of power plants
2. Analyze the steady state behavior of the power system for voltage and frequency fluctuations
3. Describe reactive power control of a power system
4. Design suitable controller to dampen the frequency and voltage steady state oscillations
5. Analyze SCADA and EMS functions

UNIT: I	LOAD –FREQUENCY CONTROL

Basics of speed governing mechanism and modeling – speed load characteristics – load sharing between two synchronous machines in parallel. Control area concept LFC control of a single-area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two area system – modeling - static analysis of uncontrolled case - tie line with frequency bias control of two-area system - state variable model.

UNIT: II	REACTIVE POWER – VOLTAGE CONTROL

Basics of reactive power control. Excitation systems – modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control - tap-changing transformer. System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT: III	ECONOMIC LOAD DISPATCH

Statement of economic dispatch problem – cost of generation – incremental cost curve - co-ordination equations without loss and with loss, solution by direct method and λ-iteration method.

UNIT: IV	UNIT COMMITMENT

Statement of Unit Commitment problem – constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. Solution methods - Priority-list methods - forward dynamic programming approach. Numerical problems on priority-list method using full-load average production cost and Forward DP method.

UNIT: V	COMPUTER CONTROL OF POWER SYSTEMS

Need of computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology – Importance of Load Forecasting and simple techniques of forecasting.

TEXT BOOKS:

1. "D. P. Kothari"," I. J. Nagrath", Modern Power System Analysis, 4th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011

2. "Olle. I. Elgerd", Electric Energy Systems Theory – An Introduction, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2nd edition, 2017

REFERENCE BOOKS:

1. "Chakrabarti &Haldar", Power System Analysis: Operation and Control, Prentice Hall of India, Third edition. January 2010
2. "C.L. Wadhwa", Electrical Power Systems – New Age International Pub. Co. Third Edition, 2016
3. "Sivanagaraju", Power System Operation and Control, Pearson Education India; 1st edition 2010

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/101/108101040/
2. https://nptel.ac.in/courses/108/104/108104052/

EE611PE: OPTIMIZATION TECHNIQUES

(Professional Elective II)

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE611PE	PEC	3	0	0	3	30	70	100

Prerequisite: Mathematics –I(MA101BS) & Mathematics –II(MA201BS)

Course Objectives:

1. To introduce various optimization techniques like classical, linear programming, transportation problem, simplex algorithm, dynamic programming
2. Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations
3. To learn characteristics of constrainedproblems
4. To explain the concept of Dynamic programming and its applications to project implementation

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

1. Explain the need of optimization of engineering systems
2. Understand optimization of electrical and electronics engineering problems
3. Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
4. Compare and contrast different unconstrained optimization methods
5. Develop algorithm using constrained non-linear programming anddynamic programming

UNIT: I	CLASSICAL OPTIMIZATION TECHNIQUES

Statement of an Optimizationproblem – design vector – design constraints – constraint surface – objective function –objective function surfaces – classification of Optimization problems. Single variable Optimization– multivariableOptimization without constraints – necessary and sufficient conditions for minimum/maximum–multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – Multivariable Optimization with inequalityconstraints – Kuhn – Tucker condition.

UNIT: II	LINEAR PROGRAMMING

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel"s approximation method – testing for optimality of balanced transportation problems.

UNIT: III	UNCONSTRAINED OPTIMIZATION TECHNIQUES

One dimensional minimization methods,Classification, Fibonacci method and Quadratic interpolation method**:**Univariant method, Powell"s method andsteepest descent method.

UNIT: IV	CONSTRAINED NONLINEAR PROGRAMMING

Characteristics of constrained problem -classification - Basic approach of Penalty Function method –Basic approach of Penalty Function method Basic approaches of Interior and Exterior penalty function methods -Introduction to convex programming problem.

UNIT: V	DYNAMIC PROGRAMMING

Dynamic programming multistage decision processes – types –concept of sub optimization and the principle of optimality – computational procedure indynamic programming – examples illustrating the calculus method of solution –examplesillustrating the tabular method of solution

TEXT BOOKS:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
2. H. S. Kasene& K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 4th edition ,2004

REFERENCE BOOKS:

1. "George Bernard Dantzig", "Mukund Narain Thapa", Linear programming, Springer series in operations research 3rd edition, 2003.
2. "H.A. Taha", Operations Research: An Introduction, 8th Edition, Pearson/Prentice Hall, 2007.
3. "KalyanmoyDeb",Optimization for Engineering Design – Algorithms and Examples, PHI Learning Pvt. Ltd, New Delhi, 2005.

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/105/111105039/

EE612PE: WIND AND SOLAR ENERGY SYSTEMS

(Professional Elective II)

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE612PE	PEC	3	0	0	3	30	70	100

Prerequisite: Nil

Course Objectives:

1. To study the physics of wind power and energy
2. To understand the principle of operation of wind generators
3. To know the solar power resources
4. To analyze the solar photo-voltaic cells
5. To discuss the solar thermal power generation

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the energy scenario and the consequent growths of the power generate renewable energy sources.
2. Identify the basic physics of wind and solar power generation.
3. Apply the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.
5. Identify the network integration issues.

UNIT: I — **PHYSICS OF WIND POWER**

History of wind power, Indian and Global statistics, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions, and Wind power-cumulative distribution functions.

UNIT: II — **WIND GENERATOR TOPOLOGIES**

Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator configurations, Converter Control.

UNIT: III — **SOLAR ENERGY TECHNOLOGIES**

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power point Tracking (MPPT) algorithms. Converter Control.

UNIT: IV — **NETWORK INTEGRATION ISSUES**

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

UNIT: V — **SOLAR THERMAL POWER GENERATION**

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis. System Thermal Calculations: Component Models, Collector Heat Exchanger Factor, Duct and Pipe Loss Factors,Controls,Collector Arrays: Series Connections, Performance of Partially Shaded Collectors, Series Arrays with Sections Having Different Orientations.

TEXT BOOKS:

1. "T. Ackermann", Wind Power in Power Systems, John Wiley and Sons Ltd., 2012.
2. "G. M. Masters", Renewable and Efficient Electric Power Systems, John Wiley and Sons, 2013.

REFERENCE BOOKS:

1. "S. P. Sukhatme", Solar Energy: Principles of Thermal Collection and Storage, McGraw Hill, 2008.
2. "H. Siegfried"," R. Waddington", "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
3. "J. A. Duffie","W. A. Beckman", Solar Engineering of Thermal Processes, John Wiley & Sons, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ch11/
2. https://nptel.ac.in/courses/103/103/103103206/

EE613PE: DIGITAL CONTROL SYSTEMS

(Professional Elective-II)

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE613PE	PEC	3	0	0	3	30	70	100

Prerequisite: Control Systems(EE404PC)

Course Objectives:

1. To understand the fundamentals of digital control systems representations, z-transforms and discrete complex domain.
2. To understand the concepts of state variables analysis for discrete LTIV systems.
3. To understand the concepts of controllability and observability of discrete time systems
4. To get exposed the design aspects of controllers and for discrete time systems
5. To understand the concepts of the stability for discrete LTIV systems

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Obtain discrete representation of LTI systems.
2. Find the state space analysis of discrete time systems.
3. Test and analyze the controllability and observability for discrete time systems
4. Analyze stability of discrete time systems using various methods
5. Design state feedback controllers and observers.

UNIT: I	REPRESENTATION OF DISCRETE TIME SYSTEMS

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Z-Transforms, Mapping from s-plane to z plane, Properties of Z-Transforms and Inverse Z Transforms. Pulse Transfer function: Pulse transfer function of closed loop systems. Solution of Discrete time systems. Time response of discrete time system, Steady State errors.

UNIT: II	DISCRETE TIME STATE SPACE ANALYSIS

State space representation of discrete time systems, Conversion of pulse transfer function to state space models and vice-versa, Solving discrete time state space equations, State Transition Matrix, Pulse Transfer Function Matrix. Discretization of continuous time state space equations. Concept of Controllability, stabilizability, observability, reachability – Controllability and observability tests. Effect of pole zero cancellation on the controllability & observability.

UNIT: III	STABILITY ANALYSIS OF DISCRETE TIME SYSTEM

Concept of stability in z-domain, Stability analysis discrete time system: by Jury test, using bilinear transformation. Stability Analysis of discrete time systems using Lyapunov methods.

UNIT: IV	DESIGN OF DIGITAL CONTROL SYSTEM BY CONVENTIONAL METHODS

Design and realization of digital PID Controller, Design of discrete time controllers with bilinear transformation, Design of digital control system with dead beat response, Practical issues with dead beat response design.

UNIT: V	DEISGN STATE FEEDBACK CONTROLLERS AND OBSERVERS

Design of discrete state feedback controllers through pole placement, Design of Discrete Observer for LTI System: Design of full order and reduced observers, Design of observer-based controllers.

TEXT BOOKS:

1. "K. Ogata",Digital Control Engineering, Prentice Hall, Englewood Cliffs, 1995.
2. "M. Gopal", Digital Control Engineering, Wiley Eastern, 1988.
3. "V, I, George"."C. P. Kurian", Digital Control Systems, CENGAGE Learning, 2012

REFERENCE BOOKS:

1. "G. F. Franklin", "J. D. Powell","M. L. Workman", Digital Control of Dynamic Systems, Addison-Wesley, 1998.
2. "B.C. Kuo", Digital Control System, Holt, Rinehart and Winston, 1980.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/103/108103008/

EE614PE: VLSI DESIGN

(Professional Elective II)

B.Tech III year II semester

Course Code	Category	Hours/Week			Credits	Max Marks		
		L	T	P	C	CIA	SEE	Total
EE614PE	PEC	3	0	0	3	30	70	100

Prerequisite : Digital Electronics(EE403PC)

Course Objectives :

1. Give exposure to different steps involved in the fabrication of ICs using MOS transistor, CMOS/BICMOS transistors.
2. Explain electrical properties of MOS and BiCMOS devices to analyze the behavior of inverters designed with various loads.
3. Give exposure to the design rules to be followed to draw the layout of any logic circuit.
4. Provide concept to design different types of logic gates using CMOS inverter and analyze their transfer characteristics.
5. Provide design concepts to design building blocks of data path of any system using gates.
6. Understand basic programmable logic devices and testing of CMOS circuits.

Course Outcomes : Upon successful completion of the course, students will be able to:

1. Acquire qualitative knowledge about the fabrication process of integrated circuits using MOS transistors.
2. Draw the layout of any logic circuit which helps to understand and estimate parasitic of any logic circuit
3. Design different types of logic gates using CMOS inverter and analyze their transfer characteristics
4. Design building blocks of data path subsystems and memories using basic digital logic devices.
5. Design simple logic circuits using PLA,PAL, FPGA and CPLD
6. Understand different types of faults that can occur in a system and learn the concept of testing.

UNIT- I	INTRODUCTION

Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS.

Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vdsrelationships,MOS transistor threshold Voltage, gm, gds, Figure of merit;Pass transistor,NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

UNIT- II	VLSI CIRCUIT DESIGN PROCESSES

VLSI Circuit Design Processes:VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout,Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits.

UNIT- III	GATE LEVEL DESIGN

Gate Level Design :Logic Gates and Other complex gates, Switch logic, Alternate gate circuits, Time delays, Driving large capacitive loads, Wiring capacitance, Fan – in, Fan – out, Choice of layers

UNIT- IV	DATA PATH SUBSYSTEMS & ARRAY SUBSYSTEMS

Data Path Subsystems: Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Zero/One Detectors, Counters.

Array Subsystems: SRAM, DRAM, ROM, Serial Access Memories

UNIT- V	PROGRAMMABLE LOGIC DEVICES & CMOS TESTING

Programmable Logic Devices: Design Approach – PLA, PAL, Standard Cells, FPGAs, CPLDs.

CMOS Testing:CMOS Testing, Test Principles, Design Strategies for test, Chip level Test Techniques.

Text Books :

1. Essentials of VLSI circuits and systems – Kamran Eshraghian, EshraghianDougles and A.Pucknell, PHI, 2005.
2. CMOS VLSI Design – A Circuits and Systems Perspective, Neil H. E Weste, David Harris,Ayan Banerjee, 3rd Ed., Pearson, 2009.

Reference Books :

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. CMOS Logic circuit Design - John .P. Uyemura, Springer, 2007.
3. Modern VLSI Design - Wayne Wolf, Pearson Education, 3rd Ed., 1997.

Web References :

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/
3. http://www.vlsi-expert.com/p/vlsi-basic.html

E-text Books :

1. https://www.phindia.com/Books/ShoweBooks/MTMzMA/MTE2NA/VLSI-Design
2. http://www.cmosvlsi.com/
3. https://www.springer.com/gp/book/9781402084461
4. https://books.google.co.in/books?id=CO8zq6_vcr8C&printsec=frontcover

EE605PC: ELECTRICAL SYSTEMS SIMULATION LAB

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE605PC	PCC	0	0	2	1	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC),
Softwares Required: MATLAB/PSCAD/PSPICE/PSIM

Course Objectives:

1. To perform voltage distributions across insulator strings
2. To understand the high frequency transients
3. To perform parameter estimation and fault analysis on Transmission lines
4. To perform parameter estimation and fault analysis on Transmission lines

Course Outcomes: Upon completing this course, the student will be able to

1. Analyze various transmission line calculations
2. Determine time constants for RL, RC and RLC circuits
3. analyze the Voltage distribution across insulator string
4. Determine fault currents of transmission line
5. Analyze the experimental data and draw the conclusions

List of Experiments:

1. Generation of high frequency transients through RLC circuit
2. Voltage distribution across insulator string
3. Comparison of lumped and distributed transmission lines
4. Calculation of fault currents of transmission line
5. Time constant calculation of RL circuit
6. Time constant calculation of RC circuit
7. Time constant calculation of RLC circuit
8. Simulation of Resonance circuit
9. Calculation of R, L, C, Zs of 3-phase Transmission Line
10. Estimation of TARIFF based on load curve

EE606PC: MICROPROCESSORS AND MICROCONTROLLERS LAB

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE606PC	ESC	0	0	2	1	30	70	100

Prerequisite: Digital Electronics(EE403PC)

Course Objectives:

1. To develop an understanding of the Assembly language programming on 8086Microprocessor.
2. To develop an understanding of the interfacing techniques with 8086 Microprocessor.
3. To develop an understanding of the Assembly language programming using Keil IDE on 8051µc.
4. To develop an understanding of the interfacing techniques with 8051 Microcontroller.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand and apply the knowledge of addressing modes, instruction set & assembler directives of 8086 to perform arithmetic operations, sorting& String programs using MASM.
2. Design & test the function of Stepper motor and 8255by interfacing with 8086.
3. Understand and apply the knowledge of addressing modes, instruction set of 8051 to perform arithmetic, logical & bit manipulation programs using Keil.
4. Able to verify the operation of timer/counter/UART/interrupt handler in 8051.

List of Experiments:

Cycle 1: Using 8086 Processor Kits and/or Assembler (6 Weeks)

1. Assembly Language Programs to perform Arithmetic, Logical, and String Operations.
2. Assembly Language Programs to perform Rotate, Shift, Swap and Branch Operations.
3. Interfacing stepper motor, ADC & DAC to 8086.

Cycle 2: Using Keil IDE**- (5 weeks)-**

1. Assembly Language Programs to Perform Arithmetic, Logical Operations.
2. Assembly Language Programs to perform Rotate, Shift, Swapand Branch Instructions
3. Time delay Generation Using Timers of 8051.
4. UART operation (Serial communication) in 8051.
5. Program and verify interrupt handling in 8051.

Cycle 3: Interfacing I/O Devices to 8051 (5 Weeks)

1. Interfacing LCD to 8051
2. Interfacing Matrix Keyboard to 8051
3. Interfacing 8-bit ADC to 8051.
4. Interfacing DAC to 8051.

List of Equipment/Software (with Specifications or Range) Required:

1. Computer Systems(Intel) with Windows 7 or higher Operating System
2. MASM 611 Software (Open source)
3. Keil µVision IDE Software (Open Source)
4. 8086 µp kits, stepper motor interfacing module,8051µc kits, LCD interfacing module,Matrix Keyboard interfacing module, ADC interfacing module, DAC interfacing module.

EE607PC: DIGITAL SIGNAL PROCESSING LAB

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE607PC	ESC	0	0	2	1	30	70	100

Prerequisite: Nil

Course Objectives:

1. To Generate and characterize various continuous and discrete time signals
2. Find frequency response of systems
3. Design of digital IIR and FIR filters
4. To implement Laplace transform on a given signal

Course Outcomes: Upon completing this course, the student will be able to

1.Understand basics of MATLAB syntax, functions and programming
2. Generate and characterize various continuous and discrete time signals.
3. Analyze the spectral characteristics of signals using Fourier analysis.
4. Analyze the systems using Laplace transform and Z-transform.
5.Design and simulate Digital IIR and FIR filter using MATLAB
6.Analyse frequency response for the given system

List of Experiments:

1. Basic Operations on Matrices.
2. Generation of Various Signals and Sequences (Periodic and Aperiodic), such as Unit Impulse,Unit Step, Square, Saw tooth, Triangular, Sinusoidal, Ramp, Sinc.
3. Operations on Signals and Sequences such as Addition, Multiplication, Scaling, Shifting,Folding, Computation of Energy and Average Power.
4. Finding the Even and Odd parts of Signal/Sequence and Real and Imaginary parts of Signal.
5. Convolution for Signals and sequences.
6. Verification of Linearity and Time Invariance Properties of a given Continuous/DiscreteSystem.
7. Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum.
8. Waveform Synthesis using Laplace Transform.
9. Locating the Zeros and Poles and plotting the Pole-Zero maps in S-plane and Z-Plane for thegiven transfer function.
10. Verification of Sampling Theorem.
11. To find Frequency Response of a given System given in Transfer Function/ Differentialequation form.
12. Implementation of LP FIR Filter for a given Sequence/Signal.
13. Implementation of HP IIR Filter for a given Sequence/Signal
14. Impulse Response of First order and Second Order Systems.

List of Equipment/Software(with Specifications or Range) Required:

The Programs shall be implemented in Software (Using MATLAB / Lab View / C Programming/ Equivalent)

MC610: CYBER SECURITY

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
MC610	MC	3	0	0	0	100	0	100

Prerequisite: NIL

Course Objectives:

1. To familiarize various types of cyber-attacks and cyber-crimes
2. To give an overview of the cyber laws
3. To study the defensive techniques against these attacks

Course Outcomes: After completion of this course the student is able to

1. Cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks.

UNIT: I	INTRODUCTION TO CYBER SECURITY

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT: II	CYBERSPACE AND THE LAW & CYBER FORENSICS

Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT: III	CYBERCRIME

Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT: IV	CYBER SECURITY

Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem.

UNIT: II	LINEAR PROGRAMMING:

Introduction, Revised Simplex Method, Duality in Linear Programming, Decomposition Principle, Sensitivity or Postoptimality Analysis, Transportation Problem, Karmarkar"s Method, Quadratic Programming

UNIT: III	NON-LINEAR PROGRAMMING

Introduction, Unimodal Function, Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods, Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods, Rate of convergence, Design variables, Random search methods, Chrivariate methods, Powell"s method, Newton"s method, Marquard Method, Test function.

Unit: IV	GEOMETRIC PROGRAMMING

Introduction, Posynomial, Unconstrained Minimization Problem, Primal-Dual Relationship and Sufficiency Conditions in the Unconstrained Case,Constrained Minimization, Primal and Dual Programs in the Case of Less-Than Inequalities, Geometric Programming with Mixed Inequality Constraints, Complementary Geometric Programming, Applications of Geometric Programming.

Unit: V	DYNAMIC PROGRAMMING

Introduction, Multistage Decision Processes, Concept of Sub optimization and the Principle of Optimality, Computational Procedure in Dynamic Programming, The Calculus Method of Solution, The Tabular Method of Solution, Conversion of a Final Value Problem into an Initial Value Problem, Linear Programming as a Case of Dynamic Programming, Continuous Dynamic Programming, Applications.

TEXT BOOKS:

1. "C B Gupta" , Optimization Techniques in Operations Research, 1st Edition, I K International Publications, New Delhi, 2013.
2. "Singireshel S Rao", Engineering Optimizations, 4th Edition, Elsevier Butterworth, Heineman, USA, 2011.

REFERENCE BOOKS:

1. "Jasibir Arora", Introduction to Optimum Design, 4th Edition, Academic press in an Imprint of Elsevier, USA,2016.
2. "N V S Raju", Optimization Methods for Engineering, 1st edition, PHI Publications, New Delhi, 2014
3. "Edwin K", "P Chang", "Stanislaw H. Zak", An Introduction to Optimization, 3rd Edition, Jhon Wiley, New York, 2013

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://www.udemy.com/course/optimization-for-engineering-students

EE701PC: POWER SEMICONDUCTOR DRIVES

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE701PC	PCC	2	0	0	2	30	70	100

Prerequisite: Power Electronics(EE501PC),Electrical Machines–I(EE304PC), Electrical Machines -II(EE402PC)

Course Objectives:

1. To introduce the drive system and operating modes of drive and its characteristics
2. To understand Speed – Torque characteristics of different motor drives by various power converter topologies
3. To appreciate the motoring and braking operations of drive
4. To differentiate DC and AC drives

Course Outcomes: After completion of this course the student is able to

1. Identify the drawbacks of speed control of motor by conventional methods.
2. Differentiate Phase controlled and chopper-controlled DC drives speed-torque characteristics merits and demerits
3. Understand 3-phase Induction motor drive speed–torque characteristics using different control strategies its merits and demerits
4. Apply Slip power recovery scheme
5. Understand speed control of 3-phase synchronous motor drive

UNIT: I CONTROL OF DC MOTORS BY SINGLE PHASE AND THREE PHASE CONVERTERS

Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – continuous current operation – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics Problems on Converter fed d.c motors. Three phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque characteristics – Problems.

UNIT: II FOUR QUADRANT OPERATION OF DC DRIVES & CONTROL OF DC MOTORS BY CHOPPERS

Four quadrant operation of DC drives: Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking operations. Four quadrant operations of D.C motors by single phase and three phase dual converters – Closed loop operation of DC motor (Block Diagram Only) Control of DC Motors by Choppers: Single quadrant, two quadrant and four quadrant chopper fed dc separately excited and series motors – Continuous current operation – Output voltage and current wave forms – Speed and torque expressions – speed-torque characteristics – Problems on Chopper fed D.C Motors – Closed Loop operation (Block Diagram Only)

UNIT: III CONTROL OF INDUCTION MOTORS

Variable voltage characteristics-Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics. Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters-

PWM control – Comparison of VSI and CSI operations – Speed torque characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives

UNIT: IV	ROTOR SIDE CONTROL OF INDUCTION MOTOR

Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics – advantages, applications, problems.

UNIT: V	CONTROL OF SYNCHRONOUS MOTORS

Separate control and self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI, CSI and cyclo converters. Load commutated CSI fed Synchronous Motor – Operation – Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop control operation of synchronous motor drives ,variable frequency control - Cyclo converter, PWM based VSI& CSI.

TEXT BOOKS:

1. "G K Dubey", Fundamentals of Electric Drives, CRC Press, 2020
2. "Vedam Subramanyam", Thyristor Control of Electric drives, Tata McGraw Hill Publications, 2004.

REFERENCE BOOKS:

1. "S K Pillai", A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. January 2012.
2. "P. C. Sen", Thyristor DC Drives, Wiley-Blackwell, 1981
3. "B. K. Bose", Modern Power Electronics, and AC Drives, Pearson 2015.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104140/

SM702MS: FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS

B.Tech. IV Year I Sem. L T P C

3 0 0 3

Course Objective:

- To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers.

Course Outcome:

- The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.

UNIT- I:

Introduction to Management: Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach, IT Approach.

UNIT – II:

Planning and Decision Making: General Framework for Planning - Planning Process, Types of Plans, Management by Objectives; Production Planning and Control. Decision making and Problem Solving - Programmed and Non Programmed Decisions, Steps in Problem Solving and Decision Making; Bounded Rationality and Influences on Decision Making; Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

UNIT- III:

Organization and HRM: Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change. Human Resource Management & Business Strategy: Job Satisfaction, Job Enrichment, Job Enlargement, Talent Management, Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.

UNIT- IV:

Leading and Motivation: Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis; Handling Employee and Customer Complaints, Team Leadership. Motivation - Types of Motivation; Relationship between

Motivation, Performance and Engagement, Content Motivational Theories - Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.

UNIT- V:

Controlling: Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non Budgetary Controls. Characteristics of Effective Controls, Establishing control systems, Control frequency and Methods.

TEXT BOOKS:

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

REFERENCE BOOKS:

1. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.

2. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.

3. Industrial Engineering and Management: Including Production Management, T.R. Banga, S.C. Sharma, Khanna Publishers.

EE711PE- FLEXIBLE A.C. TRANSMISSION SYSTEMS
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE711PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Electronics(EE501PC), Power System-I(EE405PC), Power System-II(EE502PC)

Course Objectives:

1. To understand the fundamentals of FACTS Controllers.
2. To know the importance of controllable parameters and types of FACTS controllers & their benefits.
3. To study the objectives of Shunt and Series compensation.
4. To Control STATCOM and SVC and their comparison

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Choose proper controller for the specific application based on system requirements.
2. Analyze various systems thoroughly and their requirements.
3. Apply SVC & STATCOM for power quality improvement
4. Analyze the Power and control circuits of Series Controllers GCSC, TSSC and TCSC.
5. Design the thyristor switched series capacitor (TSSC)

UNIT: I	FACTS CONCEPTS

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, and benefits from FACTS controllers.

UNIT: II	VOLTAGE SOURCE CONVERTERS

Single phase, three phase full wave bridge converters transformer connections for 12 pulse operation.
Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

UNIT: III	STATIC SHUNT COMPENSATION

Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable var generation, variable impedance type static var generators, switching converter type var generators and hybrid var generators.

UNIT: IV	SVC AND STATCOM

FC-TCR and TSC-TCR. STATCOM. The regulation and slope. Comparison between SVC and STATCOM

UNIT: V	STATIC SERIES COMPENSATORS

Objectives of Series compensation, concept of series capacitive compensation, GTO thyristor-controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor-controlled series capacitor (TCSC) control schemes for GSC TSSC and TCSC.

TEXT BOOKS:

1. "N.G. Hingorani","L. Guygi", Understanding Facts: Concepts and Technology of Flexible AC Transmission Systems, Wiley India Pvt Ltd, 2011
2. "Yong- Hua Song, Allan Johns", Flexible AC Transmission System, Laxmi Publications, 2009

REFERENCE BOOKS:

1. "Kalyan K. Sen","Meylingsen", Introduction to FACTS Controllers, John wiley& sons, Inc., Mohamed E.EI – Hawary Series editor, 2016.
2. "K. R Padiyar", "Motilal", FACTS controllers in power transmission and distribution, New Age International Pvt Ltd; Second edition, 2016

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/107/108107114/

EE712PE: POWER SYSTEM DE-REGULATION
(PROFESSIONAL ELECTIVE III)

B. Tech. IV Year I Semester								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
EE712PE	**PEC**	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100

Prerequisite: Power System Operation and Control(EE604PC)

Course Objectives:

1. To understand restructuring of electricity market.
2. To understand the need of deregulation in electricity market.
3. To apply the concept of deregulation and ATC
4. To understand money, power & information flow in a deregulated power system.

Course Outcomes:

1. Understand the Developments of restructuring worldwide.
2. Identify the roles and responsibilities of different entities in power market.
3. Explore issues like Congestion management, Transmission pricing, Ancillary Services Management.
4. Understand operational planning activities of ISO
5. Apply Synchronous Generators as Ancillary service.

UNIT – I	**OVER VIEW OF KEY ISSUES IN ELECTRIC UTILITIES**

Introduction- restructuring models- Independent system operator (ISO)-power Exchange-Market operations-Market power -standard cost -Transmission Pricing-Congestion Pricing -Management of Inter Zonal/Intra Zonal Congestion.

UNIT – II	**OASIS (OPEN ACCESS SAME-TIME INFORMATION SYSTEM)**

Structure of OASIS-posting of Information-Transfer capability on OASIS-Definitions Transfer capabilities -ATC-TTC-TRM-CBM calculations-Methodologies to calculate ATC.

UNIT – III	**ELECTRICITY PRICING**

Introduction -Electricity price volatility-Electricity price Indexes-Challenges to electricity pricing-Construction of forward price curves-short time price forecasting.

UNIT – IV	**POWER SYSTEM OPERATION IN A COMPETITIVE ENVIRONMENT**

Introduction -operational planning activities of ISO-The ISO in Pool Markets-The ISO in Bilateral Markets -Operational Planning Activities of GENCO.

UNIT – V	**ANCILLARY SERVICES**

Introduction- Reactive power as an Ancillary service-a review based on present research-Synchronous Generators as Ancillary service Providers.

Text Books:

1. "Dr.P.V.Ramakrishna","G.Srinivas",Dr.S.V.Padmavathi", Power System Deregulation(Unit Commitment Problem),Namya Press Publication,1st edition -2020.
2. "Pawan Chandrakant Tapre", Generation Rescheduling In Deregulated Power System ,Wizard Publisher; 1st edition -2019

Reference Books:

1. "Krishna P.V. Rama", POWER SYSTEM DEREGULATION (Unit Commitment Problem) ,Namya Press-2020
2. "S.K.Gupta", Power System Operation Control & Restructuring, I K International PublishingHouse Pvt. Ltd – 2015

Web Reference:

1. https://nptel.ac.in/courses/108/101/108101005/
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/17295/13/13_chapter3.pdf
3. https://onlinelibrary.wiley.com/doi/pdf/10.1002/0470846119.fmatter_indsub
4. https://ieeexplore.ieee.org/iel5/2224/21343/00990185.pdf

EE713PE: COMPUTER METHODS IN POWER SYSTEM
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE713PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System–I(EE405PC), Power system–II(EE502PC**)** & Electrical Circuits (EE302PC)

Course Objectives:

1. To understand formation of Z bus of a transmission line.
2. To discuss power flow studies by various methods.
3. To determine short circuit analysis.
4. To analyze the power system for steady state and transient stability

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

1. Analyze power system network matrices through graph theory.
2. Discuss about the power flow studies (load-flow) through various computer methods.
3. Analyze the short-circuit analysis & per unit representation.
4. Compare symmetrical and unsymmetrical fault analysis.
5. Analyze steady-state and transient state stability in power system.

UNIT: I POWER SYSTEM NETWORK MATRICES

Graph Theory: Definitions, Bus Incidence Matrix, Y bus formation by Direct and Singular Transformation Methods, Numerical Problems.

Formation of Z Bus: Partial network, Algorithm for the Modification of Z Bus Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old busses (Derivations and Numerical Problems). - Modification of ZBus for the changes in network (Problems).

UNIT: II POWER FLOW STUDIES

Load Flows:

Necessity of Power Flow Studies – Data for Power Flow Studies – Derivation of Static load flow equations. **Load flow solutions using Gauss Seidel Method**:

Acceleration Factor, Load flow solution with and without P-V buses, Algorithm and Flowchart. Numerical Load flow Solution for Simple Power Systems (Max. 3-Buses): Determination of Bus Voltages, Injected Active and Reactive Powers (Sample One Iteration only) and finding Line Flows/Losses for the given Bus Voltages.

Newton-Raphson Method in Rectangular and Polar Co-Ordinates Form:

Load Flow Solution with or without PV Busses- Derivation of Jacobian Elements, Algorithm and Flowchart.

Decoupled and Fast Decoupled Methods:
Comparison of Different Methods – DC load Flow.

UNIT: III	SHORT CIRCUIT ANALYSIS

Per-Unit System of Representation:
Per-Unit equivalent reactance network of a three phase Power System, Numerical Problems.

Symmetrical fault Analysis:
Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems.

Symmetrical Component Theory:
Symmetrical Component Transformation, Positive, Negative and Zero sequence components: Voltages, Currents and Impedances. Sequence Networks: Positive, Negative and Zero sequence Networks, Numerical Problems.

Unsymmetrical Fault Analysis:
LG, LL, LLG faults with and without fault impedance, Numerical Problems.

UNIT: IV	STEADY STATE STABILITY ANALYSIS

Elementary concepts of Steady State, Dynamic and Transient Stabilities. Description of: Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to improve steady state stability.

UNIT: V	TRANSIENT STABILITY ANALYSIS

Derivation of Swing Equation. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation. - Solution of Swing Equation: Point-by-Point Method. Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers.

TEXT BOOKS:

1. "M.A.Pai", Computer Techniques in Power System Analysis, TMH Publications 3rd Edition July 2017.
2. "K.Umarao", Computer techniques and models in power systems, , I.K.International 1st edition, September 2014.

REFERENCE BOOKS:

1. "PSR Murty", Power System Analysis, BS Publications, January 2018
2. "HadiSaadat", Power System Analysis, , TMH, 3rd edition, 2018
3. "TuranGonen",Modern Power System Analysis, CRC Press, 2nd edition February 2013

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/107/108107127/
2. https://nptel.ac.in/courses/108/105/108105067/

EE714PE: POWER SYSTEM AUTOMATION
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
EE714PE	**PEC**	3	0	0	3	30	70	100

Prerequisite: Power System – I (EE405PC), Power System – II(EE502PC**)**

Course Objectives:

1. To explain the basics of MIMO systems and calculation of system norms
2. To design the hardware and programming of programmable logic controllers
3. To understand the real time systems and inter task communication.
4. To discuss the fundamentals of PLC and its architecture.
5. To develop the PLC programming fundamentals, process logic and human machine interface.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the need of structure and operation of power system automation.
2. Discuss the Energy Management System and its role in programmable logic controller.
3. Explain the fundamentals of SCADA.
4. Illustrate the substation automation structure and its applications.
5. Describethe various control schemes of distribution automation and its technical benefits.

UNIT: I	**INTRODUCTION**

Evolution of automation system – Benefits of power system automation, Structure of power system automation, Electrical Protection, Control, Measurement, Monitoring- Architecture for power system automation – Classification of power system automation – Substation automation and Distribution automation – Problems with Data acquisition - implementation of power system automation and protection using SCADA.

UNIT: II	**ENERGY MANAGEMENT SYSTEMS & PLC**

Introduction- EMS in Power Systems, Objectives of EMS, Evolution of EMS, Functions and Benefits of EMS, EMS Architecture, Working of EMS, Evolution of EMS.
Introduction – Basic Operation – PLC architecture and components – Programming Languages – PLC"s Applications to Power System Automation.

UNIT: III	**SCADA FUNDAMENTALS**

Introduction – Building Blocks of SCADA - SCADA in power systems – Its application functions in Generation, Transmission and Distribution – Advantages of SCADA - SCADA Communication systems - RTUs – Components of RTUs –Communication Protocols – Advanced RTU functionalities, IEDs, Data concentrators and merging units, Human Machine Interface, Classification of SCADA systems Single master–single remote, Single master–multiple RTU, Multiple master–multiple RTUs, Single master, multiple submaster, multiple remote.

UNIT: IV	SUBSTATION AUTOMATION
Need for Substation automation, Role of IEDs in SA, Conventional substations: Islands of automation, Substation automation issues, SA architectures, application functions, Enterprise-level application functions, Benefits of data analysis to utilities	
UNIT: V	**DISTRIBUTION AUTOMATION**
Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software, Distribution Automation Functions-Information management, system reliability management, system efficiency management, voltage management, Load management, Communication systems used in DA - DA communication requirements, Communication reliability, Cost effectiveness, Data rate Requirements, Two way capability, Technical Benefits of DA.	

TEXT BOOKS:

1. "Mini S Thomas", "John D McDonald",Power system SCADA and smart grids, CRC Press, 2015.
2. "James. Northcote", "Green Robert Wilson", Control and Automation of Electrical Distribution Systems, , CRC Press 1st edition 2007

REFERENCE BOOKS:

1. "Rajesh Mehra", "Vikrant Vij", PLCs and SCADA- Theory and Practice, LaxmiPublications, First edition, 2016.
2. "Dr. M. K. Khedkar", "Dr. G.M.Dhole", Electric Power Distribution Automation, University Science press,2010

WEB REFERENCES:

1. https://www.electricalindia.in/power-system-automation/
2. https://nptel.ac.in/courses/108/105/108105063/

EE721PE: HVDC TRANSMISSION

(Professional Elective-IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE721PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC), Power System Protection(EE603PC), Power System Operation and Control(EE604PC), Power Electronics(EE501PC)

Course Objectives:

1. To compare EHV AC and HVDC systems
2. To analyze Graetz circuit and also explain 6 and 12 pulse converters
3. To control HVDC systems with various methods and to perform power flow analysis inAC/DC systems.
4. To describe various protection methods for HVDC systems and Harmonics

Course Outcomes: After completion of this course the student is able to

1. Compare EHV AC and HVDC system and to describe various types of DC links
2. Analyze Graetz circuit for rectifier and inverter mode of operation
3. Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems
4. Discuss various protection methods for HVDC systems
5. Analyze the classification of Harmonics and design different types of filters.

UNIT: I CONVERTERS FOR HVDC TRANSMISSION

Basic Concepts Necessity of HVDC systems, Economics and Terminal equipment of HVDC transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission.

Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulse and 12 Pulse converters, Cases of two 3 phase converters in Y/Y mode – their performance.

UNIT: II CONTROL OF HVDC SYSTEM

Converter and HVDC System Control: Principle of DC Link Control, Converters Control Characteristics, firing angle control, Current and extinction angle control, Effect of source inductance on the system, Starting and stopping of DC link, Power Control.

Reactive Power Control in HVDC: Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients.

UNIT: III POWER FLOW ANALYSIS IN HVDC SYSTEMS

Modelling of DC Links, DC Network, DC Converter, Controller Equations, Solution of DC load flow, P.U. System for DC quantities, solution of AC-DC Power flow-Simultaneous method-Sequential method.

UNIT: IV	PROTECTION OF CONVERTERS

Converter Faults and Protection: Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, Audible noise, space charge field, corona effects on DC lines, Radio interference.

UNIT: V	HARMONIC ANALYSIS

Characteristics of harmonics, calculation of AC Harmonics, Non harmonics Characteristics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics

Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

TEXT BOOKS:

1. "K. R. Padiyar", HVDC Power Transmission Systems, New Age International Publishers, 2017
2. "S K Kamakshaiah, V Kamaraju", HVDC Transmission, Mc Graw Hill Publishers, 2020

REFERENCE BOOKS:

1. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 2016.
2. "Jos Arrillaga", HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 2008.
3. "E. W. Kimbark", Direct Current Transmission, John Wiley and Sons, volume 1, 1971.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104013/
2. https://nptel.ac.in/courses/108/106/108106160/

EE722PE: POWER QUALITY

(Professional Elective IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE722PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power systems – II(EE502PC)

Course Objectives:

1. To understand the power quality and different terms of power quality.
2. To compare short and long interruption.
3. To study about voltage sag and its effects.
4. To know the behavior of power electronics loads.

Course Outcomes: Upon completing this course, the student will be able to

1. Discuss the severity of power quality problems in distribution system.
2. Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
3. Explain the concept of improving the power quality.
4. Discuss various methods of mitigation in DC drives.
5. Analyze power quality issues by the VSI converters.

UNIT: I **INTRODUCTION**

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

UNIT: II **LONG & SHORT INTERRUPTIONS**

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short interruptions: definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

UNIT: III **VOLTAGE SAG CHARACTERIZATION**

Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

UNIT: IV **POWER QUALITY ISSUES IN INDUSTRIES**

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

UNIT: V	MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller. Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

TEXT BOOKS:

1. **"**Roger C. Dugan**"** , "Mark F. Mcgranaghan**"**, "Surya Santoso" , "H. Wayne Beaty**"**,ElectricalPower Systems Quality, McGraw Hill Education; 3rd edition -2017
2. "Math H J Bollen", Understanding Power Quality Problems by Bollen, Wiley India-2011

REFERENCE BOOKS:

1. "P. Sanjeevikumar", "C. Sharmeela", "Jens Bo Holm-Nielsen", "P. Sivaraman", Power Quality in Modern Power Systems, Academic Press-2020
2. "Bhim Singh","AmbrishChandra","Kamal", "Al-Haddad",Power Quality: Problems and Mitigation Techniques, John Wiley & Sons, Inc.- 2015

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/102/108102179/
2. https://nptel.ac.in/courses/108/107/108107157/

EE723PE: ADVANCED CONTROL SYSTEMS
(Professional Elective IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE723PE	PEC	3	0	0	3	30	70	100

Prerequisite: Control Systems(EE404PC)

Course Objectives:

1. To discuss about stability analysis
2. To understand about phase plane analysis
3. To explain describing function analysis
4. To understand observability and controllability

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the basics of advanced control systems.
2. Analyze stability analysis of control systems in frequency domain through polar &nyquist plots
3. Design of lag, lead, lag-lead compensators in frequency domain,
4. Analyze the stability of continuous systems.
5. Apply concept of controllability and observabilty.

UNIT: I	FREQUENCY BASED STABILITY ANALYSIS AND CONTROLLERS DESIGN

Frequency Domain: Polar Plots-Nyquist Plots-Stability Analysis. Lag, Lead, Lead-Lag Controllers design in frequency Domain.

UNIT: II	STABILITY ANALYSIS THROUGH LYAPUNOV METHODS

Stability in the sense of Lyapunov. Lyapunov"s stability and Lypanov"s instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.

UNIT: III	PHASE-PLANE ANALYSIS

Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems

UNIT: IV	DESCRIBING FUNCTION ANALYSIS

Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems.

UNIT: V	STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS

Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it"s Properties – Concepts of Controllability and Observability.

TEXT BOOKS:

1. "B. N. Sarkar", Advanced Control Systems, PHI Learning Private Limited, 2013
2. "Somanath Majhi", Advanced Control Theory, Cengage Learning, 2nd Edition June 2009

REFERENCE BOOKS:

1. "S.Palani", Control Systems Engineering, Tata-McGraw-Hill, 2nd Edition 2010
2. "I. J. Nagrath and M. Gopal" Control Systems Engineering, , New Age International (P) Limited, Publishers,6th Edition,2017
3. "K. Ogata", Modern Control Engineering,Prentice Hall of India, 5th Edition,2015.
4. M. Gopal, Modern Control System Theory, New Age International Publishers,4th Edition, 2014

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/103/108103007/
2. https://nptel.ac.in/courses/108/107/108107115/

EE724PE: ELECTRICAL MACHINE DESIGN
(Professional Elective - IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE724PE	PEC	3	0	0	3	30	70	100

Prerequisite: Electrical Machines-I(EE304PC), Electrical Machines-II(EE402PC**)**

Course Objectives:

1. To know the major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings.
2. To analyze the thermal considerations, heat flow, temperature rise, rating of machines.
3. To understand the design of transformers.
4. To study the design of induction motors.
5. To know the design of synchronous machines.
6. To understand the CAD design concepts.

Course Outcomes: Upon completing this course, the student will be able to

1. Design the construction and performance characteristics of electrical machines.
2. Analyze the various factors which influence the design of electrical, magnetic and thermal loading of electrical machines.
3. Apply the principles of electrical machine design and carry out a basic design of an ac machine.
4. Use software tools to do design calculations.
5. Analyze the design considerations of induction motors.

UNIT: I	INTRODUCTION

Major considerations in electrical machine design, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines. Introduction to design aspects of modern machines PMDC,PMAC,PMSMs, BLDCs, and claw-pole machines.

UNIT: II	SWITCHED RELUCTANCE MOTORS

Design aspects of stator and rotor pole arcs, design of stator and rotor and pole arcs in SR motor-determination of $L(\theta)$--- θ profile – power converter for SR motor-A numerical example –Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems—derivation of torque expression, general linear case.

UNIT: III	INDUCTION MOTORS

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT: IV	SYNCHRONOUS MACHINES

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT: V	COMPUTER AIDED DESIGN (CAD)

Limitations (assumptions) of traditional designs need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design.

TEXT BOOKS:

1. "A. K. Sawhney", A Course in Electrical Machine Design, Dhanpat Rai and Sons, 2016.
2. "M.G. Say", Theory & Performance & Design of A.C. Machines, ELBS London.

REFERENCE BOOKS:

1. "S. K. Sen", Principles of Electrical Machine Design with computer programmes, Oxford and IBH Publishing, 2006.
2. "K. L. Narang", A Text Book of Electrical Engineering Drawings, Satya Prakashan, 1969.
3. "A. Shanmugasundaram", "G. Gangadharan"," R. Palani", Electrical Machine Design Data Book, New Age International, 1979.
4. "M. V. Murthy",Computer Aided Design of Electrical Machines, B.S. Publications, 2008.
5. "Electrical machines and equipment design exercise examples using Ansoft"s Maxwell 2D machine design package.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106023/
2. https://nptel.ac.in/courses/108/105/108105131/

EE703PC: ELECTRICAL AND ELECTRONICS DESIGN LAB

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE703PC	PCC	0	0	2	1	30	70	100

Prerequisite: Basic Electrical Engineering(EE103ES)

Course Objectives:

1. To enhance practical knowledge related to different subjects
2. To develop hardware skills such as soldering, winding etc.
3. To develop debugging skills.
4. To increase ability for analysis and testing of circuits.
5. To fabricate basic electrical circuit elements/networks

Course Outcomes: Upon completing this course, the student will be able to

1. Get practical knowledge related to electrical
2. Trouble shoot the electrical circuits
3. Design filter circuit for application
4. Get hardware skills such as soldering, winding etc.
5. Get debugging skills.

List of Experiments:

Group A:

1. Design and fabrication of reactor/ electromagnet for different inductance values.
2. Design and fabrication of single-phase Induction/three phase motor stator.
3. Start delta starter wiring for automatic and manual operation.
4. Wiring of distribution box with MCB, ELCB, RCCB and MCCB.
5. Wiring of 40 W tube, T-5, LED, Metal Halide lamps and available latest luminaries.
6. Assembly of various types of contactors with wiring.
7. Assembly of DOL and 3-point starter with NVC connections and overload operation.

Group B:

This group consists of electronic circuits which must be assembled and tested on general purpose PCB or bread boards.

1. Design and development of 5 V regulated power supply.
2. Design and development of precision rectifier.
3. Design and development of first order/ second order low pass/high pass filters with an application.
4. Microcontroller Interface circuit for temperature/level/speed/current/voltage measurement.
5. Peak detector using op-amplifiers.
6. Zero crossing detector using op-amplifiers.
7. PCB design and layout.

WEB REFERENCES:

1. http://vlabs.iitkgp.ernet.in/be/index.html#
2. https://vem-iitg.vlabs.ac.in/Star%20Delta%20Starting(intro).html

EE811PE: EHVAC TRANSMISSION SYSTEMS

(Professional Elective V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE811PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power systems – II(EE502PC)

Course Objectives:

1. To understand the basic concepts of EHV AC transmission.
2. To get the Knowledge on EHV AC transmission line inductance and capacitance
3. To understand the voltage gradients of conductor and corona effects on transmission lines
4. To determine electrostatic fields of EHV AC lines.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the basic concepts of EHV AC transmission.
2. Determine EHV AC transmission line inductance, capacitance and the voltage gradients of conductor
3. Explain about the corona effects on transmission lines
4. Analyze electrostatic fields of EHVAC lines and its effects
5. Distinguish various compensators for voltage control.

UNIT: I **PRELIMINARIES**

Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses- mechanical considerations – resistance of conductors – properties of bundled conductors – bundle spacingand bundle radius- Examples.

UNIT: II **LINE AND GROUND REACTIVE PARAMETERS AND VOLTAGEGRADIENTS OF CONDUCTORS**

Line inductance and capacitances – sequence inductances and capacitances – modes of propagation –ground return –Examples. Electrostatics – field of sphere gap – field of line changes and properties – charge

– potential relations for multi-conductors – surface voltage gradient on conductors – distribution of voltage

gradient on sub-conductors of bundle – Examples.

UNIT: III **CORONA EFFECTS**

Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between 1-phase and 3-phase AN level – Examples. Radio interference (RI) - corona pulses generation, properties, limits – frequency spectrum –

modes of propagation – excitation function – measurement of RI, RIV and excitation functions – Examples.

UNIT: IV **ELECTRO STATIC FIELD**

Calculation of electrostatic field of EHV/AC lines – effect on humans, animals and plants – electrostatic induction in un energized circuit of double-circuit line – electromagnetic interference-Examples. Traveling Wave Theory: Traveling wave expression and solution- source of excitation terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed
lines- generalized constants-No load voltage conditions and charging current.

UNIT: V	**LINE COMPENSATION**

Power circle diagram and its use – voltage control using synchronous condensers – cascade connection of

shunt and series compensation – sub synchronous resonance in series capacitor – compensated lines – staticVAR compensating system.

TEXT BOOKS:

1. "R. D. Begamudre", EHVAC Transmission Engineering, New Age International (p) Ltd., 4th Edition2011.
2. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 2016

REFERENCE BOOKS:

1. "E. Kuffel, W. S. Zaengl, J. Kuffel", High Voltage Engineering Fundamentals, Elsevier, 3 rd Edition2016.
2. "Mazen Abdel-salam, Hussein Ains, Abdab EI – Mors hedy and Roshdy Radwan", High VoltageEngineering: Theory and Practice, CRC Press, 2nd Edition 2000.
3. "Hugh M. Ryan", High Voltage Engineering and Testing, IEE power and energy series 32, TheInstitution of Engineering and Technology 2nd edition 2001.

WEB REFERENCES:

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee24/
2. https://nptel.ac.in/courses/108/108/108108099/

EE812PE: ARTIFICIAL INTELLIGENT TECHNIQUES FOR ELECTRICAL SYSTEMS
(Professional Elective - V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE812PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System – I (EE405PC), Power system – II(EE502PC)&Power Systems Operation and Control (EE604PC)

Course Objectives:

1. To understand the concepts of Artificial Intelligence techniques
2. To understand the ANN Models and their training algorithms
3. To understand the concepts of the Fuzzy Logic System and formulation of FLS solutions for Electrical Engineering Applications
4. To understand the concepts of Genetic Algorithm and formulation of its solution to some of Electrical Engineering Applications.

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

1. Apply AI techniques for solving complex problems.
2. Apply the ANN for load forecasting and other mapping related problems in Electrical Engineering
3. Develop Fuzzy Logic Control for applications in electrical engineering
4. Develop Genetic Algorithm for optimum solutions for applications in electrical engineering.
5. Develop the hybrid systems for solving complex problems.

UNIT: I	FUNDAMENTALS OF AI TECHNIQUES AND ARTIFICIAL NEURAL NETWORKS (ANN)

Introduction Artificial Intelligence, Artificial Intelligence Techniques and their potential applications, Fundamentals of Artificial Neural networks (ANN). Biological Neuron Models, Artificial neuron Models, Models of Neural Network-Architectures –Knowledge representation, and Neural networks–Learning Paradigms:-Error correction learning, Hebbian learning –Competitive learning-Boltzman learning, Supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks.

UNIT: II	ANN ARCHITECTURES, TRAINING ALGORITHMS

Single Layer Perceptron, Multi-layer perceptron, Training of Multi-Layer Neural Networks: Back propagation Algorithm (BPA), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT: III	FUZZY LOGIC SYSTEMS (FLS)

Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy Cartesian Product, Operations on Fuzzy relations –Fuzzy logic–Fuzzy Quantifiers. Fuzzy Logic Systems: Fuzzification, -Fuzzy Rule based system, Fuzzy Inference, Defuzzification methods. Fundamental of Fuzzy Logic Control: Mamdani Architecture and The Sugano-Takagi Architecture.

UNIT: IV	GENETIC ALGORITHMS(GA)

Introduction-Encoding –Fitness Function-Reproduction operators, Genetic Modeling –Genetic Operators-Cross over-Single site cross over, Two point cross over –Multi point cross over Uniform cross over, Matrix cross over-Cross over Rate-Inversion & Deletion, Mutation operator –Mutation – Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

UNIT: V	**APPLICATIONS OF AI TECHNIQUES**

ANN Applications in Electrical Engineering: Load forecasting, Turing of control parameters and Speed control of Electrical Motors. FLS Applications in Electrical Engineering: Load frequency Control, Reactive Power Control and Speed control of DC and AC motors. GA Applications in Electrical Engineering: Economic load dispatch, Scheduling of loads, Turing of control parameters

TEXT BOOKS:

1. "S. Rajasekaran"."G.A.V. Pai", Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, June 2013.
2. "Rober J. Schalkoff", Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

REFERENCE BOOKS:

1. John Yen and Reza Langari, Fuzzy Logic: Intelligence, Control, and Information, Pearson Education, 2004
2. P.D.Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York, 1989.
3. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall,1992
4. D.E.Goldberg, Genetic Algorithms, Addison-Wesley 1999.

WEB REFERENCES:

1. https://www.electricalindia.in/artificial-intelligence-an-advanced-approach-in-power-systems/
2. https://nptel.ac.in/courses/108/104/108104112/
3. https://onlinecourses.swayam2.ac.in/arp19_ap60/preview

EE813PE: ADVANCED POWER ELECTRONICS

(Professional Elective V)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE813PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Electronics(EE501PC)

Course Objectives:

1. To understand various advanced power electronics devices.
2. To describe the operation of multi-level inverters with switching strategies for high power applications.
3. To comprehend the design of resonant converters.
4. To understand the operation of switched mode power supplies.

Course Outcomes: Upon completing this course, the student will be able to

1. Develop various converter topologies.
2. Design AC or DC switched mode power supplies.
3. Understand the operation of buck boost converter.
4. Design I / P and O/P characteristics of various DC-DC converters.
5. Design Multilevel Inverters.

UNIT: I	MODERN POWER SEMICONDUCTOR DEVICES

Modern power semiconductor devices. MOS turn off Thyristor (MTO)-Emitter Turn off Thyristor (ETO) – Integrated Gate- Commutated Thyristor (IGCT) – MOS – controlled Thyristors (MCTs) – Static Induction Circuit –. gallium nitride devices, Silicon carbide devices

UNIT: II	ISOLATED DC-DC CONVERTERS

Isolated DC-DC converters forward, fly-back, push-pull, half-bridge and full –bridge converters Relationship between I / P and O/P voltages. Expression for filter inductor and capacitors.

UNIT: III	SOFT SWITCHING AND RESONANT CONVERTERS

Concept of ZVS and ZCS Zero voltage transition converters. Resonant converters- Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies and applications in lighting

UNIT: IV	MULTI-INVERTERS

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converter' s configurations; Features and relative comparison of these configurations" applications

UNIT: V	MODULATION TECHNIQUES

Single PWM – Multiple PWM – sinusoidal PWM – modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped,

harmonic injection and delta modulation – Advantages – Applications & Problems Introduction to carrier based PWM technique for multi-level converters, techniques for reduction for harmonics, phase shifted

Modular multilevel inverters.

TEXT BOOKS:

1. "M.H.Rashid," Power Electronics – Circuits, Devices & Applications, PHI, 4th edition , July 2013
2. "Ned Mohan, T.M. Undeland, William P.Robbins," Power Electronics: Converters, Applications: John Wiley &Sons,Third edition January 2007

REFERENCE BOOKS:

1. "Taylor Morey, KeithH.Billing,AbrahanL.Pressman", Switching Power supply Design, Mc.Graw Hill International third editionEdition, 2009
2. "Andrzej M. Trzynadlowski", Introduction to Modern Power Electronics, 2nd Edition, illustrated Publisher John Wiley & Sons, 2010

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_ee28/preview
2. https://nptel.ac.in/courses/108/107/108107128/

EE814PE: SMART ELECTRIC GRID

(Professional Elective V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE814PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Systems –II(EE502PC), Power System Operation and Control(EE604PC), Power System Protection(EE603PC)

Course Objectives:

1. To understand various aspects of the smart grid
2. To discuss about intelligrid and SCADA.
3. To illustrate issues and challenges that remain to be solved.
4. To analyze basics of various aspects in electricity market operations.

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

1. Understand the structure of an electricity market in either regulated or deregulated market conditions.
2. Discuss the advantages of DC distribution and developing technologies in distribution
3. Determine the trade-off between economics and reliability of an electric power system.
4. Compare various investment options in electricity markets.
5. Analyze the development of smart and intelligent domestic systems

UNIT: I INTRODUCTION TO SMART GRID

Introduction to smart grid- Electricity Network-Local energy networks Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. Smart Grid to Evolve a Perfect Power System: Introduction- Overview of the perfect power system configurations-Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT: II DC DISTRIBUTION AND SMART GRID

AC vs DC sources-Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future Neighborhood-Potential future work and research. Intelligrid Architecture for the Smart grid: Introduction- Launching intelligrid- Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies. SCADA, synchro phasors (WAMS).

UNIT: III CONCEPTS OF DYNAMIC ENERGY SYSTEMS

Smart energy efficient end use devices-Smart distributed energy resources-Advanced whole building control systems- Integrated communications architecture-Energy Management-Role of technology in demand responseCurrent limitations to dynamic energy management-Distributed energy resources-Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

UNIT: IV	ENERGY PORT AS PART OF THE SMART GRID

Concept of energy -Port, generic features of the energy port.

Policies and Programs to Encourage End – Use Energy Efficiency: Policies and programs in action -multinational - national-state-city and corporate levels.

Market Implementation: Framework-factors influencing customer acceptance and response - program planning-monitoring and evaluation.

UNIT: V	EFFICIENT ELECTRIC GRID

Use Technology Alternatives: Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners - Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS:

1. "I S Jha,SubirSen,RajeshKumar,D P Kothari",Smart Grid Fundamentals &Applications,New Age International Publishers; First edition -2019
2. "Stuart Borlase",Smart Grids: Advanced Technologies and Solutions, Second Edition, CRC Press-2018

REFERENCE BOOKS:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"-Wiley, IEEE Press, 2012.

WEB REFERENCES:

1. https://www.smartgrid.gov/the_smart_grid/smart_grid.html
2. https://www.i-scoop.eu/industry-4-0/smart-grids-electrical-grid/
3. https://nptel.ac.in/courses/108/107/108107113/

EE821PE: UTILIZATION OF ELECTRIC POWER

(Professional Elective VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE821PE	PEC	3	0	0	3	30	70	100

Prerequisite: Electrical Machines-I(EE304PC), Electrical Machines-II (EE402PC)& Basic Electrical Engineering (EE103ES)

Course Objectives:

1. To understand the fundamentals of electric drives.
2. To discuss about the illumination and good lighting practices.
3. To describe the practical applications ofA.C. and D.C. Welding.
4. To understand concepts of electric traction.

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

1. Analyze thecharacteristicsofelectric drives.
2. Determine the concepts and methods of electric heating, welding,
3. Discuss the concepts and methods of illumination
4. Explain the concepts and methods of electric traction
5. Apply the concepts ofelectrical and electronics problems of real world.

UNIT: I	ELECTRIC HEATING & WELDING

Advantages and methods of electric heating, resistance heating induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT: II	ILLUMINATION

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

Various Illumination Methods: Discharge lamps, MV and SV lamps – comparison Between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Typesand design of lighting and flood lighting.

UNIT: III	ELECTRIC TRACTION

System of electric traction and track electrification. Mechanics of train movement-adhesive weight and coefficient of adhesion Speed-time curves for different services – trapezoidal and Quadrilateral speed time curves. Traction motors methods of electric braking-plugging rheostat braking and regenerative braking. Control of traction motors-series-parallel control, Shunt transition, bridge transition,

UNIT: IV	TRACTION LIGHTING SYSTEM

Special requirements of train lighting, methods of obtaining unidirectional polarity constant output- singlebattery system, Double battery parallel block system, coach wiring, lighting by making use of 25KV AC
supply.

UNIT V	TRACTION SUBSTATION

Traction substation, spacing and location of Traction substations, Major equipment at traction substation, selection and sizing of major equipment like transformer and Switchgear, Types of protection provided for Transformer and overhead lines, surge protection, maximum demand and load sharing between substations,
sectionalizing paralleling post and feeder posts,

TEXT BOOKS:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press, 2006
2. Partab, H., "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Sons, New Delhi, 2014.
3. Electrical Railway Transportation Systems by Morris Brenna, Federica Foiadelli and Dario Zaninelli, IEEE Press and Wiley, 2018

REFERENCE BOOKS:

1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 2017.
2. Tripathy, S.C., "Electric Energy Utilisation and Conservation", Tata McGraw Hill Publishing Company Ltd. New Delhi, 1991
3. Electric Traction – Motive Power and Energie Supply by Andreas Steimel, OldenbourgIndustrieverlag GmbH, 2008
4. Power Electronics and Electric Drives for Traction Applications Edited by Gonzalo Abad, Wiley, 2017

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105060/
2. https://nptel.ac.in/courses/108/102/108102046/

EE822PE: HYBRID ELECTRIC VEHICLES

(**Professional Elective-VI**)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE822PE	PEC	3	0	0	3	30	70	100

Prerequisite: Mathematics-I(MA101BS), Mathematics-II(MA201BS), Applied Physics (PH202BS), Power Semiconductor Drives (EE701PC).

Course Objectives:

1. To understand the fundamental concepts of hybrid and electricvehicles.
2. To discuss various aspects of hybrid and electric drive train.
3. To describe electric traction and electric propulsion.
4. To understand energy storage systems

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

1. Describe hybrid vehicles and their performance.
2. Illustrate the different possible ways of energy storage.
3. Discuss different strategies related to energy storage systems.
4. Estimate electric drives system efficiency.
5. Design of a Hybrid Electric Vehicle (HEV)

UNIT: I **INTRODUCTION TO ELECTRIC VEHICLES**

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT: II **INTRODUCTION TO HYBRID ELECTRIC VEHICLES**

History of hybrid and electric vehicles, social andenvironmental importance of hybrid and electric vehicles, impact of modern drive-trains on energysupplies.

Basic concept of hybrid traction, introduction to various hybrid drive-traintopologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

UNIT: III **ELECTRIC TRAINS**

Electric Drive-trains: Basic concept of electric traction, introduction to various electricdrive 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 Motordrives,configuration and control of Permanent Magnet Motor drives, Configuration and control of SwitchReluctance Motor drives, drive system efficiency

UNIT: IV **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: V	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)

TEXT BOOKS:

1. "C. Mi, M. A. Masrur", "D. W. Gao", Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons, 2011.
2. "S. Onori", "L. Serrao", "G. Rizzoni", Hybrid Electric Vehicles: Energy Management Strategies,Springer, 2015.

REFERENCE BOOKS:

1. "M. Ehsani", "Y. Gao", "S. E. Gay", "A. Emadi", Modern Electric, Hybrid Electric, and Fuel CellVehicles: Fundamentals, Theory, and Design, CRC Press, 2004.
2. "T. Denton", Electric and Hybrid Vehicles, Routledge, 2016

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/102/108102121/

EE823PE: CONTROL SYSTEMS DESIGN

(Professional Elective-VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE823PE	PEC	3	0	0	3	30	70	100

Prerequisite: Control Systems (EE404PC)

Course Objectives:

1. To know the time and frequency domain design problem specifications.
2. To understand the effect of addition of zero on system response
3. To understand the design of classical control systems in time-domain
4. To design of various controllers
5. To identify the performance of the systems by design them in state-space

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

1. Understand various design specifications
2. Design control system in time domain
3. Design control system in frequency domain
4. Design controllers to satisfy the desired design specifications using simple controller structures(P, PI, PID, compensators)
5. Design controllers using the state-space approach.

UNIT: I	DESIGN SPECIFICATIONS

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

UNIT: II	DESIGN OF CLASSICAL CONTROL SYSTEM IN THE TIME DOMAIN

Introduction to compensator. Design of Lag, lead, lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

UNIT: III	DESIGN OF CLASSICAL CONTROL SYSTEM IN FREQUENCY DOMAIN

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

UNIT: IV	DESIGN OF PID CONTROLLERS

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

UNIT: V	CONTROL SYSTEM DESIGN IN STATE SPACE

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman"s Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle. Non-linearities and Its Effect on System Performance: Various

types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

TEXT BOOKS:

1. N. Nise, "Control system Engineering", John Wiley, 2018
2. I. J. Nagrath and M. Gopal, "Control system engineering", New Age International Private Limited, 2021.

REFERENCE BOOKS:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, June 2016.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 2020.
3. N. Nise, "Control system Engineering", John Wiley, 2018

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106098/
2. http://nptel.iisc.ac.in/nptel/courses/control-system-design/

EE824PE: RELIABILITY ENGINEERING AND APPLICATION TO POWER SYSTEM

(Professional Elective-VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE824PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC), Power System Operation and Control(EE604PC)

Course Objectives:

1. To describe the generation system model and recursive relation for capacitive model building.
2. To explain the equivalent transitional rates, cumulative probability and cumulative frequency.
3. To develop the understanding of risk, system and load point reliability indices.
4. To explain the basic and performance reliability indices.

Course Outcomes: Upon the completion of this course, the student will be able to

1. Estimate loss of load and energy indices for generation systems model
2. Describe merging generation and load models
3. Apply various indices for distribution systems
4. Evaluate reliability of interconnected systems
5. Analyze the Open and Short circuit failures

UNIT: I BASIC PROBABILITY THEORY

Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation – Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution.

Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models - Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time between failures.

UNIT: II GENERATING SYSTEM RELIABILITY ANALYSIS

Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal –Evaluation of loss of load and energy indices – Examples. Frequency and Duration methods –Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units –2-level daily load representation- merging generation and load models – Examples.

UNIT: III OPERATING RESERVE EVALUATION

Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modeling using STPM approach.

Bulk Power System Reliability Evaluation: Basic configuration – conditional probability approach –system and load point reliability indices – weather effects on transmission lines – Weighted averagerate and Markov model – Common mode failures.

Inter Connected System Reliability Analysis: Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie –

Two connected Systems with correlated loads – Expression for cumulative probability and Cumulative frequency.

UNIT: IV	DISTRIBUTION SYSTEM RELIABILITY ANALYSIS

Basic Techniques – Radial networks –Evaluation of Basic reliability indices, performance indices – load point and system reliability indices – customer oriented, loss and energy-oriented indices – Examples. Basic concepts of parallel distribution system reliability

UNIT: V	SUBSTATIONS AND SWITCHING STATIONS

Effects of short-circuits - breaker operation – Open and Short circuit failures – Active and Passive failures – switching after faults – circuit breaker model – preventive maintenance – exponential maintenance times

TEXT BOOKS:

1. "R. Billinton", "R.N. Allan",Reliability Evaluation of Power systems, BS Publications, 2008.
2. "J. Endrenyi",Reliability Modeling in Electric Power Systems, John Wiley and Sons, 1978

REFERENCE BOOKS:

1. "Alessandro Birolini",Reliability Engineering: Theory and Practice, Springer Publications, 2017.
2. "Charles Ebeling",An Introduction to Reliability and Maintainability Engineering by, TMH,2017Publications.
3. "E. Balaguruswamy",Reliability Engineering by, TMH Publications, 2017

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/108/105108128/

EE600OE: RENEWABLE ENERGY SOURCES
(Open Elective-I)

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE600OE	OEC	3	0	0	3	30	70	100

Prerequisite: NIL

Course Objectives:

1. To develop the awareness of energy conservation
2. To identify the use of renewable energy sources for electrical power generation
3. To classify different energy storage methods.
4. To explain about environmental effects of energy conversion.

Course Outcomes: Upon completing this course, the student will be able to

1. Understand the principles of wind power and solar photovoltaic power generation, fuel cells.
2. Assess the cost of generation for conventional and renewable energy plants
3. Design suitable power controller for wind and solar applications
4. Analyze the issues involved in the integration of renewable energy sources to the grid
5. Discuss the various energy storage methods.

UNIT: I	ECONOMICS RENEWABLE ENERGY

Grid-Supplied Electricity-Distributed Generation-Renewable Energy Economics-Calculation of Electricity Generation Costs –Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

Wind Power Plants: Appropriate Location -Evaluation of Wind Intensity -Topography - Purpose of the Energy Generated - General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy Analysis of
Small Generating Systems.

UNIT: II	PHOTOVOLTAIC POWER PLANTS AND FUEL CELLS

Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parameters for Photovoltaic Panels- Photovoltaic Systems-Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy.

The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues Constructional Features of Proton Exchange-Membrane Fuel Cells –Reformers-Electro-lyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent
Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel.

UNIT: III	INDUCTION GENERATORS

Principles of Operation-Representation of Steady-State Operation-Power and Losses Generated-Self Excited Induction Generator-Magnetizing Curves and Self-Excitation Mathematical Description of the Self-Excitation Process-Interconnected and Stand-alone operation -Speed and Voltage Control -
Economical Aspects.

UNIT: IV	STORAGE SYSTEMS

Energy Storage Parameters-Lead–Acid Batteries-Ultra Capacitors-Flywheels –Superconducting Magnetic Storage System-Pumped Hydroelectric Energy Storage - Compressed Air Energy Storage - Storage Heat -Energy Storage as an Economic Resource.

UNIT: V	INTEGRATION OF ALTERNATIVE SOURCES OF ENERGY:

Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach Integration of Multiple Renewable Energy Sources-Islanding and Interconnection Control-DG Control and Power Injection.**Interconnection of Alternative Energy Sources with the Grid:** Interconnection Technologies - Standards and Codes for Interconnection - Interconnection Considerations - Interconnection Examples for Alternative Energy Sources.

TEXT BOOKS:

1. "John Twidell" ,"Tony Weir", Renewable Energy Resources, Routledge,2015
2. "Mehmet Kanoglu","YunusA.Cengel","JohnM.Cimbala", Fundamentals and Applications of Renewable Energy,McGraw-Hill Education,2020

REFERENCE BOOKS:

1. "S.C. Bhatia", "R.K. Gupta" , Renewable Energy, Woodhead,2018
2. "Mehmet Kanoglu", "Yunus A. Cengel", "John M. Cimbala" ,Fundamentals and Applications of Renewable Energy | Indian Edition -2020
3. "Anand Tembulkar", "S.P. Meher, Kataria",Non-Conventional Energy Sources,2013

WEB REFERENCES:

1. https://www.eia.gov/energyexplained/renewable-sources/
2. https://nptel.ac.in/courses/103/103/103103206/

EE601OE: RELIABILITY ENGINEERING

(Open Elective-I)

B.TECH. III YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE601OE	OEC	3	0	0	3	30	70	100

Prerequisite: Laplace Transforms, Numerical Methods and Complex variables (MA401BS)

Course Objectives:

1. To understand the basic concepts of reliability, various models of reliability
2. To analyze reliability of various systems
3. To discuss the concept of Discrete Markov Chains
4. To explain the techniques of frequency and duration for reliability evaluation of repairable Systems

Course Outcomes: Upon completing this course, the student will be able to

1. Discuss various systems of reliability networks
2. Evaluate the reliability of simple and complex systems
3. Estimate the limiting state probabilities of repairable systems
4. Apply various distribution functions for reliability evaluation.
5. Apply various mathematical models for evaluating reliability of irreparable systems

UNIT: I BASIC PROBABILITY THEORY

Elements of probability, probability distributions, Random variables, Density and Distribution functions- Mathematical expected – variance and standard deviation Binomial Distribution: Concepts, properties, engineering applications.

UNIT: II NETWORK MODELING AND EVALUATION OF SIMPLE SYSTEMS

Basic concepts- Evaluation of network Reliability / Unreliability - Series systems, Parallel systems - Series-Parallel systems- Partially redundant systems- Examples. Conditional probability method- tie set, Cut-set approach- Event tree and reduced event tree methods Relationships between tie and cut-sets- Examples

UNIT: III PROBABILITY DISTRIBUTIONS IN RELIABILITY EVALUATION

Distribution concepts, Terminology of distributions, General reliability functions, Evaluation of the reliability functions, shape of reliability functions –Poisson distribution – normal distribution, exponential distribution, Weibull distribution.

Network Reliability Evaluation Using Probability Distributions:

Reliability Evaluation of Series systems, Parallel systems – Partially redundant systems- determination of reliability measure- MTTF for series and parallel systems – Examples.

UNIT: IV DISCRETE MARKOV CHAINS

Basic concepts- Stochastic transitional probability matrix- time dependent probability evaluation- Limiting State Probability evaluation- Absorbing states – Application.

Continuous Markov Processes: Modeling concepts- State space diagrams- Unreliability evaluation of single and two component repairable systems

UNIT: V FREQUENCY AND DURATION TECHNIQUES

Frequency and duration concepts, application to multi state problems, Frequency balance approach.

Approximate System Reliability Evaluation: Series systems – Parallel systems- Network reduction techniques- Cut set approach- Common mode failures modeling and evaluation techniques- Examples.

TEXT BOOKS:

1. "Roy Billinton", " Ronald N Allan", Reliability Evaluation of Engineering Systems, Plenum Press 2013.
2. "E. Balagurusamy", Reliability Engineering by Tata McGraw-Hill Publishing Company Limited 2017

REFERENCE BOOKS:

1. "Alessandro Birolini", Reliability Engineering: Theory and Practice Springer Publications-2018
2. "Charles Ebeling", An Introduction to Reliability and Maintainability Engineering, TMH Publications 2017.
3. "Elsayed A", Reliability Engineering , Third Edition ,John Wiley and Sons Ltd 2021

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/101/111101004/
2. https://nptel.ac.in/courses/105/108/105108128/

EE700OE: ESTIMATION AND COSTING OF ELECTRICAL SYSTEMS
(Open Elective - II)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE700OE	OEC	3	0	0	3	30	70	100

Prerequisite: NIL

Course Objectives:

1. To understand the estimation and costing aspects of all electrical equipment
2. To explain the concept of installation and designs on the cost viability.
3. To design overhead and underground distribution lines.
4. To design substations and illumination.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the design considerations of electrical installations.
2. Design electrical installation for buildings and small industries.
3. Identify the various types of light sources for different applications.
4. Classify various types of substations.
5. Design of illumination schemes

UNIT: I **DESIGN CONSIDERATIONS OF ELECTRICAL INSTALLATIONS**

Electric Supply System, Three phase four wire distribution system, Protection of Electric Installation against over load, short circuit and Earth fault, Earthing, General requirements of electrical installations, testing of installations, Indian Electricity rules, Neutral and Earth wire, Types of loads, Systems of wiring, Service connections , Service Mains, Sub-Circuits, Location of Outlets, Location of Control Switches, Location of Main Board and Distribution board, Guide lines for Installation of Fittings, Load Assessment, Permissible voltage drops and sizes of wires, estimating and costing of Electric installations.

UNIT: II **ELECTRICAL INSTALLATION FOR DIFFERENT TYPES OF BUILDINGS AND SMALL INDUSTRIES**

Electrical installations for residential buildings – estimating and costing of material, Electrical installations for commercial buildings, Electrical installations for small industries.

UNIT: III **OVERHEAD AND UNDERGROUND TRANSMISSION AND DISTRIBUTION LINES**

Introduction, supports for transmission lines, Distribution lines – Materials used, Underground cables, Mechanical Design of overhead lines, Design of underground cables.

UNIT: IV **SUBSTATIONS**

Introduction, Types of substations, Outdoor substation – Pole mounted type, Indoor substations – Floor mounted type.

UNIT: V **DESIGN OF ILLUMINATION SCHEMES**

Introduction, Terminology in illumination, laws of illumination, various types of light sources, Practical lighting schemes LED, CFL and OCFL differences.

TEXT BOOKS:

1. "K. B. Raina, S. K. Bhattacharya", Electrical Design Estimating and Costing, New Age International Publisher, 2010.
2. "Er. V. K. Jain, Er. Amitabh Bajaj", Design of Electrical Installations, University Science Press. January 2016

REFERENCE BOOKS:

1. Code of practice for Electrical wiring installations(System voltage not exceeding 650 volts), Indian Standard Institution, IS: 732-1983.
2. Guide for Electrical layout in residential buildings, Indian Standard Institution, IS: 4648-1968.
3. Electrical Installation buildings Indian Standard Institution, IS: 2032.
4. Code of Practice for selection, Installation of Maintenance of fuse (voltage not exceeding 650 V), Indian Standard Institution, IS: 3106-1966.
5. Code of Practice for electrical wiring, Installations (system voltage not exceeding 650 Volts), Indian Standard Institution, IS: 2274-1963.
6. "Gupta J. B., Katson, Ludhiana", "Electrical Installation, estimating and costing", S. K. Kataria and sons, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105104/

EE701OE: ENGINEERING OPTIMIZATION
(Open Elective – II)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE701OE	OEC	3	0	0	3	30	70	100

Prerequisite: Mathematics-I(MA101BS), Mathematics-II(MA201BS)

Course Objectives:

1. To enable the student to understand Multivariable optimization techniques
2. To enable the student to understand Linear and Non – Linear Programming of various optimization techniques
3. To enable the student to understand Geometric Programming of Engineering optimization techniques
4. To enable the student to understand Dynamic Programming of various optimization techniques

Course Outcomes: : After Completion of this course, student will be able to

1. Explain various optimization techniques.
2. Illustrate various problems involving single variable and multi variables under constrained or unconstrained environments.
3. Discuss the impact of various factors affecting the Linear programming problem and solution using sensitivity (Post Optimality) analysis, with the aid of Simplex Method, Revised Simplex Method, Dual Simplex Method etc
4. Apply dynamic programming technique to find optimum solution for inventory, capital budgeting, resource allocation, Production planning and control problems etc.
5. Evaluate quadratic, geometric and non-linear programming problems using different methods.

UNIT: I	OPTIMIZATION TECHNIQUE

Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem.

UNIT: II	LINEAR PROGRAMMING:

Introduction, Revised Simplex Method, Duality in Linear Programming, Decomposition Principle, Sensitivity or Postoptimality Analysis, Transportation Problem, Karmarkar"s Method, Quadratic Programming

UNIT: III	NON-LINEAR PROGRAMMING

Introduction, Unimodal Function, Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods, Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods, Rate of convergence, Design variables, Random search methods, Chrivariate methods, Powell"s method, Newton"s method, Marquard Method, Test function.

Unit: IV	GEOMETRIC PROGRAMMING

Introduction, Posynomial, Unconstrained Minimization Problem, Primal-Dual Relationship and Sufficiency Conditions in the Unconstrained Case,Constrained Minimization, Primal and Dual Programs in the Case of Less-Than Inequalities, Geometric Programming with Mixed Inequality Constraints, Complementary Geometric Programming, Applications of Geometric Programming.

Unit: V	DYNAMIC PROGRAMMING

Introduction, Multistage Decision Processes, Concept of Sub optimization and the Principle of Optimality, Computational Procedure in Dynamic Programming, The Calculus Method of Solution, The Tabular Method of Solution, Conversion of a Final Value Problem into an Initial Value Problem, Linear Programming as a Case of Dynamic Programming, Continuous Dynamic Programming, Applications.

TEXT BOOKS:

1. "C B Gupta" , Optimization Techniques in Operations Research, 1st Edition, I K International Publications, New Delhi, 2013.
2. "Singireshel S Rao", Engineering Optimizations, 4th Edition, Elsevier Butterworth, Heineman, USA, 2011.

REFERENCE BOOKS:

1. "Jasibir Arora", Introduction to Optimum Design, 4th Edition, Academic press in an Imprint of Elsevier, USA,2016.
2. "N V S Raju", Optimization Methods for Engineering, 1st edition, PHI Publications, New Delhi, 2014
3. "Edwin K", "P Chang", "Stanislaw H. Zak", An Introduction to Optimization, 3rd Edition, Jhon Wiley, New York, 2013

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://www.udemy.com/course/optimization-for-engineering-students

EE800OE: ENERGY STORAGE SYSTEMS
(Open Elective – III)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE800OE	OEC	3	0	0	3	30	70	100

Prerequisite: Engineering Chemistry(CH102BS)

Course Objectives:

1. To understand the need for energy storage, devices and technologies available and their applications
2. To discuss the role of electrical storage technologies
3. To explain various types of energy storage systems and its comparison.
4. To explain various applications both utility use and consumer use

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

1. Analyze the characteristics of energy from various sources and need for storage
2. Classify various types of energy storage and various devices used for the purpose
3. Discuss the features of energy storage systems.
4. Explain different types of energy storage systems and its comparison.
5. Identify various real time applications.

UNIT: I **ELECTRICAL ENERGY STORAGE TECHNOLOGIES**

Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, long distance between generation and consumption, Congestion in power grids, Transmission by cable.

UNIT: II **NEEDS FOR ELECTRICAL ENERGY STORAGE**

Needs for Electrical Energy Storage: Emerging needs for EES, more renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy

UNIT: III **FEATURES OF ENERGY STORAGE SYSTEMS**

Features of Energy Storage Systems: Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG).

UNIT: IV **TYPES OF ELECTRICAL ENERGY STORAGE SYSTEMS**

Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT: V **APPLICATIONS**

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers), New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems , Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA– aggregation of many dispersed batteries.

TEXT BOOKS:

1. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.
2. The Electrical Energy Storage by IEC Market Strategy Board,2011

REFERENCE BOOKS:

1. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc21_mm34/preview
2. https://nptel.ac.in/courses/113/105/113105102/

EE801OE: ENERGY MANAGEMENT AND AUDIT
(Open Elective - III)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE801OE	OEC	3	0	0	3	30	70	100

Prerequisite: Nil

Course Objectives:

1. To discuss the conventional energy sources and their utilization.
2. To understand the importance of heat recovery and energy conservation methods and energy audit.
3. To explain different basic terms related to Indian Energy Scenario and Energy Conservation Act
4. To describe the building envelope analysis.

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

1. Explain conventional energy sources and their audit.
2. Apply the fundamentals of energy conservation and management.
3. Discuss energy audit report for different energy conservation instances.
4. Describe the energy saving methodologies.
5. Evaluate the energy saving and conservation in different electrical utilities.

UNIT: I	INTRODUCTION TO ENERGY MANGEMENT

Global & Indian Energy Scenario-Classification of Energy Sources-Energy needs of growing economy-Energy sector reform, Energy and Environment: Global Environmental Concerns, Basics of Energy and its various forms.

UNIT: II	ENERGY AUDIT, MATERIAL AND ENERGY BALANCE

Energy Audit: Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, and Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams,

UNIT: III	ENERGY ACTION PLANNING AND FINANCIAL MANAGEMENT

Energy Action Planning, Financial Management: Financial analysis techniques- Risk and sensitivity analysis- Financing options, Energy performance contracts and role of ESCOs

Energy Monitoring and Targeting: Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM).

UNIT: IV	BULIDING ENVELOPE ANALYSIS

Building Envelope – principles of analysis – Envelope performance -Envelope analysis of Existing and new buildings – Building standards for new and Existing constructions. HVAC Systems types – Energy conservation opportunities – cooling equipment – Domestic hot water Estimating HVAC Energy consumption

UNIT: V	ELECTRIC ENERGY MANAGEMENT

Principles of Electric Energy Management, Energy Management control systems – Energy systems maintenance. Energy management in water and waste water treatment – solid waste treatment- air pollution control systems. Energy Management in Boilers and Fired systems – Steam and condensate systems – cogeneration – Waste Heat recovery. Energy Management in Process Industries, Energy Security, Codes, Standards, Electricity Act, Energy Conservation Act.

TEXT BOOKS:

1. "Murphy.W. R", Energy Management Elsevier/bsp Books Pvt. Ltd,2003
2. General Aspects of Energy Management and Audit, National Productivity Council of India, Chennai (Course Material- National Certification Examination for Energy Management)

REFERENCE BOOKS:

1. Energy Management Handbook, W.C. Turner, 5th Edition, Marcel Dekker, Inc, New York, 2005.
2. Guide to Energy Management, B. L. Capehart, W. C. Turner, W. J. Kennedy, CRC Press, New York, 2005.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106022/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-me44/