Jharkhand University of Technology, Ranchi

Detailed Syllabus

5th Semester

Department of Electrical Engineering

Course structure of Electrical Engineering

Semester -5th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	**EE501**	Electrical Machine-II	4	1	0	4
02	**EE502**	Principles of Control Systems	3	1	0	3
03	**EE503**	Microprocessor and Microcontroller	3	1	0	3
04		Professional Elective-I	3	1	0	3
05		Open Elective-I	3	1	0	3
	Laboratory/sessional					
01	**EE501P**	Electrical Machine-II Lab	0	0	3	1
02	**EE502P**	Principles of Control Systems Lab	0	0	3	1
03	**EE503P**	Microprocessor and Microcontroller Lab	0	0	3	1
04	**EE504P**	Basic Computational Lab	0	0	3	1
05	**EE505P**	General Proficiency/Seminar	0	0	3	2
Total Credits						**22**

Professional Elective-I	
EE511	Signals & Systems
EE512	Electrical Machine Design
EE513	Transforms in Electrical Engineering
EE514	Applied Electrical Engineering

Open Elective-I	
EE521	Power Plant Engineering
EE522	Industrial Instrumentation and Automation
EE523	Principles of Control Systems*
EE524	Electromechanical Energy Conversion and Transformers*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

Professional Core

EE501

Electrical Machines-II

L	T	Credit
4	1	4

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of synchronous machines and induction machines.
CO2	**Analyze** the effects of excitation and mechanical input on the operation of synchronous Machine.
CO3	**Analyze** starting and speed control methods of synchronous machines and induction machines.
CO4	**Evaluate** performance characteristics of synchronous machines and induction machine.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2		1					2
CO2	3	3	2	2	2		1					2
CO3	3	3	2	2	2		1					2
CO4	3	3	2	2	2		1					2
Avg.	**3**	**3**	**2**	**2**	**2**		**1**					**2**

DETAILED SYLLABUS

Module I: Fundamentals of A.C. Machines (5 Lectures)

Fundamental principles of A.C. machines: E.M.F equation of an elementary alternator, single & three phase, factors affecting the induced e.m.f, full pitch & fractional pitch windings, winding factors, armature reaction, concept of time phasor & space phasor.

Module-II: Synchronous Generator (12 Lectures)

Various types and construction, cylindrical rotor theory, phasor diagram, open circuit & short circuit characteristics, armature reaction, synchronous reactance, SCR, load characteristics, voltage regulation, E.M.F. method, MMF method, ZPF method, Potier triangle, synchronous machine connected to infinite bus, power angle characteristics.

Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct axis and quadrature axis synchronous reactance, power angle characteristics, slip test, parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel, transient & sub-transient reactance.

Module-III: Synchronous Motor (7 Lectures)

General physical consideration, main features, equivalent circuit & phasor diagram, torque & power relations in salient and non-salient pole motors, V-curves & inverted V-curves, effect of change of excitation, synchronous condenser, starting of synchronous motor, performance characteristics of synchronous motor, hunting, applications.

Module-IV: Three Phase Induction Motor (10 Lectures)

Three Phase Induction Motors: Types, Construction and principle of operation, phasor diagrams, equivalent circuit, power and torque relations, condition for maximum torque, Performance characteristics, effect of rotor resistance on speed torque characteristics, stable & unstable region of operation, Operation with unbalanced supply voltage. Starting of 3 phase induction motor, speed control of induction motor, Double cage induction motor, Cogging and Crawling of Induction motor, induction generator.

Module-V: Single phase motors (5 Lectures)

Induction type, Double revolving field theory, equivalent circuit, characteristics & starting of single phase motor, shaded pole machine, synchronous type, hysteresis motor, reluctance motor.

Module VI: Single phase special type of machines (3 Lectures)

Switched reluctance motor, PMBLDC motor, tachometer, two phase control motor, Synchro.

Suggested Readings:

[1]. I. J. Nagrath & D. P. Kothari, "Electric Machines", Tata Mc Graw Hill, 7th Edition.2005

[2]. P. S. Bhimbra, "Electrical Machines", Khanna Publishers.

[3]. A.E. Fitzgerald, C.Kingsley and S.Umans, "Electric machinery", MacGraw Hill Companies, 5th edition.

[4]. Stephen Chapman, "Electric Machinery Fundamentals" Mac Graw HillCompany.

[5]. Langsdorf, "Theory of Alternating Current Machinery", Tata McGraw-Hill Companies, 2nd edition.

[6]. Performance and Design of AC Machines by M G. Say, BPB Publishers.

EE502

Principles of Control System

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative Stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: Introduction to Principles of Control System (8 Lectures)

Concept of systems and its classification; open-loop and closed-loop control system, benefits of feedback, mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams and its reduction techniques, Signal flow graphs and Mason's gain formula.

Module II: Time domain and Frequency domain (10 Lectures)

Time domain performance criterion, transient response of first order and second order systems; Steady state errors and error constants of different types of system; dynamic error constant: Derivation and its advantages; sensitivity; performance analysis for P, PI and PID controllers.

Module III: Stability Criterion (8 Lectures)

Concept of stability by Routh stability criterion. Stability analysis using root locus. Bode plot analysis. Absolute and Relative stability. Definition and computation of Gain Margin and Phase Margin. Comparison between time and frequency response plot.

Module IV: Stability Criterion Continued (6 Lectures)

Frequency response Polar plots and its stability criterion. Relative stability, Nyquist criterion; Graphical approach for gain and phase margin using polar plot; Advantages and disadvantages of frequency response plot.

Module V: Compensation design (4 Lectures)

Compensation - lag, lead and lag-lead networks, Compensation designs of networks using time domain analysis and frequency response analysis.

Module VI: State Space Analysis **(6 Lectures)**

Concepts of state, state variables, state space representation of systems, dynamic equations, transient matrix, merits for higher order differential equations and its solution; Concept of controllability and observability.

Suggested Readings:

[1]. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

[2]. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

[3]. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

[4]. H. Saeed, "Automatic Control System", S. K. Kataria & Sons, 2008.

[5]. S. K. Bhardwaj and S. K. Nagar, "Modern Control System with Advance Topics", New Age International, 2019.

EE503 **Microprocessor & Microcontroller**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(6 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing, Instructions Set.

Module-II **(10 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(4 Lectures)**

Interfacing of memory and peripherals with microprocessor, Architecture and modes of operation of 8255.

Module-IV **(10 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping.

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(10 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[1]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI

[2]. Badri Ram, Advanced Microprocessors and Interfacing, TMH

[3]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.

[4]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill

[5]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

Professional Elective-I

(Any One)

EE511 **Signals And Systems**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Analyze** systems in complex frequency domain.
CO3	**Understand** sampling theorem and its implications

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**								**2**

DETAILED SYLLABUS

Module I **(5 Lectures)**

Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals - Concept of system - Properties of systems - Stability, invertability, time invariance - Linearity - Causality - Memory - Time domain description - Convolution - Impulse response.

Module II **(5 Lectures)**

Representation of LTI systems - Differential equation and difference equation representations of LTI systems, Continuous Time LTI systems and Convolution Integral, Discrete Time LTI systems and linear convolution.

Module III **(5 Lectures)**

Frequency Domain Representation of Continuous Time Signals- Continuous Time Fourier Series: Convergence. Continuous Time Fourier Transform: Properties.

Module IV **(9 Lectures)**

Frequency Domain Representation of Discrete Time Signals- Discrete Time Fourier Transform: Properties, Sampling Theorem, aliasing, reconstruction filter, sampling of band pass signals. Fourier Series Representation of Discrete Time Periodic Signals.

Module V **(10 Lectures)**

Laplace Transform – ROC – Inverse transform – properties – Analysis of Continuous LTI systems using Laplace Transform – unilateral Laplace Transform. Relation between Fourier and Laplace Transforms.

Laplace transform analysis of systems - Relation between the transfer function and differential equation - Causality and stability - Inverse system - Determining the frequency response from

poles and zeros.

Module VI **(8 Lectures)**

Z Transform - Definition - Properties of the region of convergence - Properties of the Z transform - Analysis of LTI systems - Relating the transfer function and difference equation - Stability and causality - Inverse systems - Determining the frequency response from poles and zeros.

Suggested Readings:

[1]. Haykin. S., Venn B. V. Signals and Systems

[2]. Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, Tata McGraw Hill

[3]. Taylor F.H, Principles of Signals and Systems, McGraw Hill

R**eferences**

[1]. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill

[2]. Haykin S., Communication Systems, John Wiley

[3]. Lathi B.P., Modern Digital& Analog Communication Systems, Oxford University Press

[4]. Papoulis A., Fourier Integral & Its Applications, McGraw Hill

EE512 **Electrical Machine Design**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of this course, student should be able to:

CO's	CO Description
CO1	**Understand** the construction and performance characteristics of electrical machines.
CO2	**Understand** the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
CO3	**Understand** the principles of electrical machine design and carry out a basic design of an ac machine
CO4	**Analyze** design aspects of rotating electrical machines.
CO5	**Use** software tools to do design calculations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2							2
CO2	3	2	2	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	2	2							2
CO5	3	3	2	2	2							2
Avg.	**3**	**2.6**	**2.4**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Factors in Design **(8 Lectures)**

Specifications for machines, output equation, limitations in design, electric and magnetic loadings, space factor, winding factor and their effects on machine performance, mechanical and high speed problems.

Module II: Design of Poly phase Asynchronous Machines **(10 Lectures)**

Details of construction, stator design, output equation, separation of D and L ,specific loadings, leakage reactance, rotor design, slip ring and squirrel cage motors, harmonic effects and slot combination, magnetizing current and losses, prediction of characteristics.

Module III: Design of Synchronous Machines **(10 Lectures)**

Details of construction, generators, salient and non-salient pole machines, specific loadings and output equation, stator design, harmonics and reduction, armature reaction, design of field winding, short circuit ratio, voltage regulation, efficiency, differences in design between salient and non-salient pole machine.

Module IV: Design of Transformers **(8 Lectures)**

Design of single and three phase transformers, output equation, specific loadings, electro mechanical stresses on windings, no load current, temperature rise.

Module V: Thermal aspects of Design **(6 Lectures)**

Generation, flow and dissipation of heat losses, thermal capacity, temperature rise curves, ratings of machines, cooling media, ventilation, types of cooling, standard enclosures.

Suggested Readings:

[1]. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.

[2]. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.

[3]. Ion Boldea, Syed A. Nasar, "The Induction Machines Design Handbook", CRC Press.

[4]. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, "Design of Rotating Electrical Machines",Wiley

[5]. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

EE513

Transforms in Electrical Engineering

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals (4 Lectures)

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems (6 Lectures)

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

Module III: Discrete Fourier Transform (10 Lectures)

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform (5 Lectures)

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.

Module V: Fast Fourier Transforms **(4 Lectures)**

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms **(8 Lectures)**

Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Parseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

Module VII: Filter Design **(5 Lectures)**

Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Suggested Readings:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH

[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI

[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP

[2]. Digital Signal Processing, Johnson, PHI

[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

EE514 **Applied Electrical Engineering**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Capable** to model the physical system into electrical system
CO2	**Apply** mathematics for electrical systems to analysis
CO3	**Select** simulation technique for DC and AC system analysis
CO4	**Able** to design the electro-mechanical systems

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2								
CO3				2	3							
CO4			2									
Average	**3**	**3**	**2**	**2**	**3**							

DETAILED SYLLABUS

Module I: Model of Physical Systems (8 Lectures)

Introduction to physical systems: Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level system; Circuit models: RL, RC, LC, RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.

Module II: Solution of Differential Equations (12 Lectures)

Systems of linear equations, homogeneous and non-homogeneous linear equations, Polynomial equations, least squares fit; ordinary differential equations: Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor-Corrector methods; Numerical integration: Forward and backward integration rules, Trapezoidal rule, Simpson's rule, Errors of integration.

Module III: Simulation Techniques (6 Lectures)

Continuous state simulation: circuit level simulators, Discrete-event simulation: Fixed time step, variable time step; Response analysis of circuits: DC analysis, AC Analysis, Transient analysis.

Module IV: Programming in MATLAB (8 Lectures)

Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation; Plotting and analysis: two-dimensional and three-dimensional plots, Histograms, Polar plots, Function evaluation; Handling external files: saving and loading data.

Module V: PSPICE Circuit Simulator (6 Lectures)

Introduction, circuit descriptions, Input files, nodes, circuit elements, element values, sources, output variables; Analysis: DC sweep, Transient and AC analysis. PSPICE models.

Suggested Readings:

[1]. Biran A. and Breiner M., "MATLAB 5 for Engineers", 2nd edition, Addison Wesley,1999

[2]. Rashid M. H. and Rashid H. M., "SPICE for Power Electronics and Electric Power", 2nd edition, Taylor & Francis,2009

[3]. William J. P., "Introduction to MATLAB for Engineers", 3rd edition,McGraw Hill,2010.

Open Elective-I

(Any One)

EE521 **L T Credit**

Power Plant Engineering

3 1 3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Descriptions
CO1	**Describe** and **analyze** different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
CO2	**Analyze** the working and layout of thermal power plants and the different systems comprising the plant and **discuss** about its economic and safety impacts
CO3	To **define** the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.
CO4	**Discuss** and **analyze** the mathematical and working principles of different electrical equipment involved in the generation of power and to **understand** co-generation.
CO5	Discuss and analyze the mathematical and working principles of different electrical equipment involved in the generation of power and to understand co-generation.

CO's-PO's Mappings Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1		2					1
CO2	2	2	3	1	2		1					1
CO3	2		2	1		1	2					1
CO4	2		2	1		1	2					1
CO5	2	2	1	2	1	2	1					1
Avg.	**2**	**2.33**	**2**	**2.67**	**1.33**	**1.33**	**1.66**					**1**

DETAILED SYLLABUS

Module I: Introduction **(10 Lectures)**

Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine power plants, Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

Module II: Thermal Power Plants **(10 Lectures)**

Basic thermodynamic cycles, various components of steam power plant-layout-pulverized coal burners-Fluidized bed combustion-coal handling systems-ash handling systems- Forced draft and induced draft fans- Boilers-feed pumps super heater- regenerator-condenser- de-aerators, cooling towers, electrostatic precipitators.

Module III: Hydel Power Plant **(8 Lectures)**

Principle of working, Classification, Site selection; Different components & their functions; Types of Dams; Types, Characteristics & Selection of Hydro-Turbines; Mini & Micro Hydro Power Plants, Pumped Storage Power Plants.

Module IV: Diesel And Gas Turbine Power Plant **(8 Lectures)**

Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material, open and closed cycles, reheating, Regeneration and inter cooling, combines cycle.

Module V: Co-Generation (6 Lectures)

Concept; Schemes; Brief Description; Benefits & Limitations; Applications. Non-Conventional Energy Sources, Types, Brief Description, Advantages & Limitations.

Suggested Readings:

[1]. P.K.Nag, "Power Plant Engineering", Tata McGraw Hill Publications.2007

[2]. EI-Wakil M.M, "Power Plant Technology," Tata McGraw-Hill 1984

[3]. Power Plant Engineering, Gautam S, Vikas Publishing House. 2012

[4]. Power station Engineering and Economy by Bernhardt

[5]. G.A.Skrotzki and William A. Vopat- Tata McGraw Hill Publishing Company Ltd.2002

[6]. "Modern Power Station Practice", Volume B, British Electricity International Ltd., Central Electricity Generating Board,Pergamon Press, Oxford.1991

[7]. 'Power Plant Familiarization – Vol. II', NPTI Publication.

EE522 **L T Credit**

Industrial Instrumentation And Automation

3 1 3

Pre-requisites: Measurements & Instrumentation

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Apply** the concepts and analyze the performance of physical systems using transducers for measurement of physical quantities.
CO2	**Understand** various Signal Conditioning operations and design Signal Conditioning circuitry of a measurement & instrumentation system.
CO3	**Exposure** to the technology of Industrial Automation and Control.
CO4	**Implementation** of various PLCs to Automation problems in industries.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	2	2	1	1	2	2
CO2	3	3	3	3	3	2	2	1	2	2	2	2
CO3	3	3	3	3	2	2	2	1	2	1	3	2
CO4	3	3	3	3	3	2	1	1	3	2	3	2
Avg.	3	3	3	3	2.5	2.25	1.75	1.25	2	1.5	2.5	2

DETAILED SYLLABUS

Module I: **(4 Lectures)**

Introduction: Static and Dynamic characteristics of Instrument. Displacement and proximity gauges. Linear Variable Differential Transformer (LVDT), Hall-effect sensors.

Module II: **(10 Lectures)**

Measurement of Temperature, Flow, Level and Viscosity: Thermocouple, Resistance Temperature Detector (RTD), Thermistor, Radiation Pyrometer, Differential Pressure flow-meter, Variable area flow- meter, Variable reluctance transducer, Turbine flow-meter, Ultrasonic flow-meter (Both transit time and Doppler Shift), electromagnetic flow-meter and Mass flow meter, Capacitance based and Float based method, pH -probe and viscosity measurement.

Module III: **(6 Lectures)**

Measurement of Pressure, strain & Vibration: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge). Low pressure measurement, Strain Gauge, unbalanced Wheatstone bridge, Load cell, Torque Cell, Piezo-eiectric sensors, accelerometers.

Module IV: **(10 Lectures)**

Signal Conditioning and Processing: Estimation of errors and Calibration, Fundamentals of 4-20 mA current loops, Regulators and power supplies for industrial instrumentation.

Basics of Data transmission: Synchro and Servo motor. IEEE-488 bus, RS 232 and RS 485 interface. Pneumatic and Hydraulic Instrumentation system

Automation: Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems. Data Acquisition systems and PC based automation.

Module V: **(6 Lectures)**

Introduction to Automatic Control: P-I-D Control, Controller Tuning, Special Control Structures, Feed- forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control. Process and Instrumentation Diagrams.

Module VI: **(6 Lectures)**

Sequence Control: PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming, Hardware environment; Control of Machine tools: Introduction to CNC Machines.

Suggested Readings:

[1]. Doebelin, Measurement Systems, Applications and Design, Tata McGraw Hill, 2008.

[2]. Measurement & Instrumentation : Trends & Applications by M.K. Ghosh, S. Sen and S. Mukhopadhyay, Ane Books,2010

[3]. Fundamentals of Industrial Instrumentation Alok Barua, Wiley India Pvt Ltd,2011

[4]. Measurement and Instrumentation Principles, 3rdEdition, Alan S Morris, Butterworth-Heinemann, 2001

[5]. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House,2013

[6]. Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, Prentice Hall India,2012

[7]. Frank. D, Petruzella, "Programmable Logic Controllers", Tata McGraw Hill Third Edition-2010.

EE523

Principles of Control System*

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative Stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

3. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: Introduction to Principles of Control System (8 Lectures)

Concept of systems and its classification; open-loop and closed-loop control system, benefits of feedback, mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams and its reduction techniques, Signal flow graphs and Mason's gain formula.

Module II: Time domain and Frequency domain (10 Lectures)

Time domain performance criterion, transient response of first order and second order systems; Steady state errors and error constants of different types of system; dynamic error constant: Derivation and its advantages; sensitivity; performance analysis for P, PI and PID controllers.

Module III: Stability Criterion (8 Lectures)

Concept of stability by Routh stability criterion. Stability analysis using root locus. Bode plot analysis. Absolute and Relative stability. Definition and computation of Gain Margin and Phase Margin. Comparison between time and frequency response plot.

Module IV: Stability Criterion Continued (6 Lectures)

Frequency response Polar plots and its stability criterion. Relative stability, Nyquist criterion; Graphical approach for gain and phase margin using polar plot; Advantages and disadvantages of frequency response plot.

Module V: Compensation design (4 Lectures)

Compensation - lag, lead and lag-lead networks, Compensation designs of networks using time

domain analysis and frequency response analysis.

Module VI: State Space Analysis (6 Lectures)

Concepts of state, state variables, state space representation of systems, dynamic equations, transient matrix, merits for higher order differential equations and its solution; Concept of controllability and observability.

Suggested Readings:

[1]. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

[2]. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

[3]. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

[4]. H. Saeed, "Automatic Control System", S. K. Kataria & Sons, 2008.

[5]. S. K. Bhardwaj and S. K. Nagar, "Modern Control System with Advance Topics", New Age International, 2019.

EE524 **L T Credit**

Electromechanical Energy Conversion And Transformers*

3 1 3

(This course is not offered to Electrical Engg students)

Course Outcome:

After successful completion of the course students will able to:

CO's	CO Description
CO1	**Understand** the principle of operation of Electromechanical energy conversion
CO2	**Understand** the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO3	**Analyze** starting methods and speed control of DC machines.
CO4	**Analyze** parallel operation of DC Generators, single phase and three phase transformers.
CO5	**Evaluate** the performance of DC machines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2			1			2
CO2	3	3	3	1	1	2			1			2
CO3	3	3	3	2	1	2			1			2
CO4	3	3	3	2	1	2			1			2
CO5	3	3	3	2	1	2			1			2
Avg.	**3**	**3**	**3**	**1.6**	**1**	**2**			**1**			**2.0**

DETAILED SYLLABUS

Module I: Principle of Electromechanical Energy Conversion (4 Lectures)

Energy stored in electric and magnetic fields, energy conversion in single and multi-excited systems and torque production, reluctance torque; Reluctance and hysteresis motors.

Module II: General Description of Electrical Machines (5 Lectures)

Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves.

Module III: DC Machines and Commutations (9 Lectures)

Simplex lap and wave windings, emf and torque equations, interaction of the fields produced by field and armature circuits.

Module IV: DC Generators (4 Lectures)

Methods of excitation, shunt, series and compound generators, characteristics, testing.

Module V: DC Motors (4 Lectures)

Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.

Module VI: Single-phase Transformers (9 Lectures)

Principle of operation, equivalent circuit, voltage regulation and efficiency; Parallel operation.

Principle of operation and comparison with two winding transformer.

Autotransformers: Principle of operation and comparison with two winding transformer

Module VII: Three Phase Transformers (6 Lectures)

Various connections and their comparative features, harmonics in emf and magnetizing current, effect of connections and construction on harmonics; Parallel operation of three-phase transformers, sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion.

Suggested Readings:

[1]. Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery", 6th Ed., McGraw-Hill International Book Company,2008.

[2]. Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors,2005.

[3]. Say M. G. and Taylor E. O., "Direct Current Machines", 3rd Ed.,ELBS and Pitman.1986

[4]. Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Limited,2008.

[5]. Chapman S. J., "Electric Machinery Fundamentals", 4th Ed.,McGraw-Hill International Book Company, 2005

[6]. Clayton A. E. and Hancock N., "The Performance and Design of DC Machines", CBS Publishers and Distributors, 2003.

[7]. Langsdorf A. S., "Theory of AC Machines", 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.

Laboratory / Sessional

EE501P **Electrical Machines-II Laboratory** **P** **Credit**

3 **1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) No Load & blocked rotor test on a three phase induction motor & draw the circle diagram.
2) Speed control of a 3-phase induction motor by rheostatic, cascading and pole changing methods.
3) Load test on three phase induction motor & draw the various characteristics.
4) To perform slip test on a given alternator and to determine d-axis reactance (Xd) and q-axis reactance (Xq)
5) Determination of sub-transient reactance of a synchronous generator by static method.
6) To perform load test on Schrage motor at different speed setting (1000, 1400 rpm).
7) To perform open circuit test and short circuit tests on a three phase Synchronous generator and calculate its voltage regulation by Synchronous impedance method.
8) Determination of V curve and Inverted V curve of a 3-phase Synchronous motor at no-load.
9) To perform load test on single phase capacitor motor.
10) To determine the negative and zero sequence reactance of a given alternator.
11) Synchronization of two alternators and their load sharing.
12) To perform open circuit test and short circuit tests on a three phase Synchronous generator and calculate its voltage regulation by Synchronous impedance method.
13) To determine voltage regulation of three phase Synchronous generator by ZPF method.
14) To determine the core loss of a single phase transformer at varying frequency and separate the hysteresis and eddy current loss.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE502P		P	Credit
	Principles of Control System Laboratory	**3**	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To Study the time response of a closed loop second order system.
2) Study of closed loop P, PI, PID Controllers.
3) Time response analysis of LEAD compensating network.
4) Frequency response analysis of LEAD compensating network.
5) Study of temperature control of oven using PID Controller.
6) To obtain the characteristics of Synchro Transmitter and Receiver
7) To obtain transfer function of a D.C Shunt motor.
8) To plot and analyze the Root locus, Bode & Nyquist plots using MATLAB.
9) To perform dynamic system simulation using MATLAB.
10) Design of PID controller for speed control of a dc motor using MATLAB.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE503P **P** **Credit**

Microprocessor & Microcontroller Laboratory

3 **1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

Microprocessor

1) Write an ALP for addition of two 8 bit numbers, result may be of more than 8 bit.
2) Write an ALP to find the largest/ smallest number in a data array.
3) Write an ALP to arrange the numbers of data array in ascending/descending order.
4) Write an ALP to move a block of data from a location of memory to another location of memory.
5) Design an interfacing circuit to interface 64KB of memory with 8085 microprocessor.
6) Design an interfacing circuit to interface a common anode/ cathode seven segment LED display with microprocessor and write an ALP to display digit 0 to 9 and letter A to F.
7) Write a program for addition of content of the memory location 3000:0400H to the contents of 4000:0700H and store the result in 6000:0900H by using instructions of 8086 microprocessor.
8) Design an interfacing circuit to interface 8255 with 8085 microprocessor and write an ALP for controlling LEDs with switches.
9) Write an ALP to find square of an 8 bit number using look up table.
10) Write a program for generation of square wave.

Microcontroller

1) Write a program in assembly language/C language to send data on ports of 8051 microcontroller.
2) Write a program in assembly language/C language to perform various arithmetic operations.
3) Write a program in assembly language/C language to read dot-matrix keyboard.
4) Write a program in assembly language/C language to display massage on multiple 7 segment display.
5) Write a program in assembly language/C language to generate 1kHz square wave on port line of 8051
6) Write a program in assembly language/C language to perform various logical operations.
7) Write a program in assembly language/C language to display message on LCD display.
8) Write a program in assembly language/C language to rotate stepper motor in clockwise direction.
9) Write a program in assembly language/C language send MSBTE on hyper terminal of PC.
10) Write a program in assembly language/C language to read ADC.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE504P		P	Credit
	Basic Computational Laboratory		
		3	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

These experiments can be performed using any software / FOSS (Free and Open Source Software) available at the institute.

1) To create arrays and matrices and perform various arithmetic operations.
2) To write a programme for getting the desired data (largest, smallest, a range etc) from a set.
3) To write a programme for creating various types of 2D plots (single and multiple) from a set of data.
4) To write a programme to solve linear equations.
5) To perform Scientific Computation.
6) Write a program for Logical Operation.
7) To perform Laplace Transform of Symbolic Expression.
8) Write a program to evaluate Eigen values and Eigen Vector of a matrix
9) To measure and plot the Instantaneous, RMS and average values of current/voltage, power, power factor, crest factor, frequency and various other waveform parameters while simulation of behavior of basic circuit components supplied from a DC and an AC source.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

Jharkhand University of Technology, Ranchi

Detailed Syllabus

6th Semester

Department of Electrical Engineering

Course structure of Electrical Engineering

Semester -6th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	EE601	Power Systems-II	4	1	0	4
02	EE602	Power Electronics	3	1	0	3
03	EE603	Advanced Control Systems	3	1	0	3
04		Professional Elective-II	3	1	0	3
05		Open Elective-II	3	1	0	3
06						
	Laboratory/ Sessional					
01	EE601P	Power System-II Lab	0	0	3	1
02	EE602P	Power Electronics Lab	0	0	3	1
03	EE603P	Simulation Lab	0	0	3	1
04	EE604P	Electrical Workshop	0	0	3	1
05		Internship/Tour & Training/Industrial Training	0	0	3	2
Total credit						22

Professional Elective-II	
EE611	Electrical Estimation and Costing
EE612	Electrical Engineering Materials
EE613	Power System Restructuring
EE614	Green Energy Technology

Open Elective-II	
EE621	Advanced Control Systems*
EE622	Soft Computing Techniques
EE623	Power Electronics*
EE624	Mine Electrical Engineering*
EE625	Green Energy Technology*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

Professional Core

EE601 **Power Systems-II**

L	T	Credit
4	1	4

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Illustrate** power system components using single line diagram and usage of per unit system.
CO2	**Calculate** symmetrical components and examine different types of faults (both symmetrical and unsymmetrical).
CO3	**Formulate** nodal admittance (Y-bus) matrix, and **develop** load flow equations and **find** its solution.
CO4	**Calculate** optimal generator allocations and analyze single area power system for load frequency control
CO5	**Illustrate** the concept of stability, power angle curve, and swing equation and diagnose steady-state and transient stability of the power system.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2	1	2								
CO3	3	3	1	3								1
CO4	3	3	1	2								1
CO5	3	3	1	3	2							1
Avg.	**3**	**2.6**	**1**	**2.5**	**2**							**1**

DETAILED SYLLABUS

Module I: Per Unit System **(4 lectures)**

Per Unit meaning and its calculation. Need and advantages of per unit system, Single line diagram, Per unit representation of a given power system network, Change of base value Impedance diagram, Numerical problems

Module II: Faults Analysis: **(8 lectures)**

Symmetrical fault Analysis: Short Circuit Current and MVA Calculations, Fault levels, Reactors-Numerical Problems. Symmetrical Component Theory: Symmetrical Component Transformation, Sequence Networks: Positive, Negative and Zero sequence Networks for transformers, transmission line and synchronous machine, Numerical Problems. Unsymmetrical Fault Analysis: LG, LL, LLG faults, Interconnection of sequence networks, effect of fault impedance, Numerical Problems

Module III: Load Flow Analysis **(8 lectures)**

Bus classification, formulation of Ybus matrix, power flow equations. Gauss – Seidel method, algorithm, derivation of iterative equation, modification for PV bus, Advantages and disadvantages, acceleration factor, Numerical Problems, Newton – Raphson method, algorithm, power mismatch vector, size of Jacobian matrix and its elements. Advantages and disadvantages, Numerical Problems, FDLF.

Module IV: Economic Operation of Power Systems **(6 lectures)**

Input-output characteristics of thermal and hydro plants, Optimum generator allocations without and with transmission losses, calculation of penalty factors, incremental transmission loss, transmission loss coefficients and their calculations.

Module V: Load Frequency Control **(8 lectures)**

Necessity of keeping frequency constant, Modeling of speed governing, steam turbine and generator, Definition of Control area, Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Proportional plus Integral control of single area and its block diagram representation, , Two area system, block diagram, Tie-line-bias control.

Module VI: Stability **(8 lectures)**

Concept of stability and Classification, Description of Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability, Methods to improve steady state stability. Derivation of Swing Equation, Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation.

Suggested Readings:

[1]. J Grainger and W.D. Stevenson , " Power System Analysis '' , McGraw Hill Education , First Edition, 2017

[2]. Hadi Sadat, "Power System Analysis", PSA Publishing LLC, Third Edition, 2011

[3]. D.P. Kothari and I.J. Nagrath, " Modern Power System Analysis '' ,McGraw Hill Education 2003

Reference Books:

[1]. Prabha Kundur, "Power System Stability and Control", McGraw Hill Education; First Edition, 2006.

[2]. A.J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley and Sons, 2011.

EE602 **Power Electronics**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and it's various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices (10 Lectures)

Power Diode, BJT, MOSFET, IGBT, Thyristor, and GTO: constructional features, I-V Characteristics, switching Characteristics, Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a Thyristor.

Module II: AC-DC Converters (8 Lectures)

Introduction, Single-phase half-wave and full-wave rectifiers with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter (6 Lectures)

Introduction, Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, quadrant operation of chopper. Power circuit of a buck, boost and buck-boost converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module IV: Single-Phase Voltage Source Inverter (6 Lectures)

Introduction, Single-phase voltage source inverter, operation and analysis, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage. Current source inverter.

Module V: Three-Phase Voltage Source Inverter (6 Lectures)

Three-phase voltage source inverter, operation and analysis, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation.

Module VI: AC Voltage Controllers (6 Lectures)

Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, Cycloconvertor.

Suggested Readings:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.

[2]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[3]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.

[4]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

EE603 **Advanced Control Systems**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction (8 Lectures)

Introduction to digital control system, Examples of Data control systems, Sampler, Sampling Theorem, Data Reconstruction: Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: Modeling discrete-time systems by pulse transfer function (8 Lectures)

Revisiting Z-transform: Introduction to Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations. Mapping of S-plane to Z-plane, Pulse transfer function, Pulse transfer function of closed loop system, sampled signal flow graph

Module III: State Space Analysis (12 Lectures)

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and its Properties.

Discrete state space model: Introduction to state variable model, various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation.

Module IV: Controllability, Observability & Stability (8 Lectures)

Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability. Stability analysis of discrete time systems: Jury stability

test Stability analysis using Bi-linear transformation.

Module V: State Feedback Controller (6 Lectures)

Design of state feedback controller through pole placement – Necessary and sufficient conditions. Observer: Full Order Observer, Reduced Order Observer. Lyapunov Stability Theorem.

Suggested Readings:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition

[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.

[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

Professional Elective-II
(Any One)

EE611 **Electrical Estimation & Costing**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the purpose of estimation and costing.
CO2	**Understand** distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses..
CO3	**Analyze** design of lighting points and its number, total load, sub-circuits, size of conductor.
CO4	**Understand** types of service mains and estimation of service mains and power circuits.
CO5	**Estimate** overhead transmission and distribution systems and its components.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	1	1						2
CO2	3	3	3	2	1	1						2
CO3	3	3	3	2	1	1						2
CO4	3	3	3	2	1	1						2
CO5	3	3	3	2	1	1						2
Avg.	**3**	**3**	**3**	**2**	**1**	**1**						**2**

DETAILED SYLLABUS

Module I: Principles of Estimation **(5 Lectures)**

Introduction to estimation & costing, Electrical Schedule, Catalogues, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Labor conditions, Determination of cost material and labour,Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, General idea about IE rule, Indian Electricity Act and major applicable I.E rules.

Module II: Residential Building Electrification **(7 Lectures)**

Introduction to electrical symbols, their advantages and requirement. Concept of wiring diagram, schematic diagrams and their types. General Rules guidelines for wiring of residential installation and positioning of equipments, Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Method of drawing single line diagram. Selection of type of wiring and rating of wires and cables Load calculations and selection of size of conductor, Selection of rating of main switch Distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential

installation.

Module III: Electrification of Commercial Installation (7 Lectures)

Concept of commercial installation, Differentiate between electrification of residential and commercial installation, Fundamental considerations for planning of an electrical installation system for commercial building, Design considerations of electrical installation system for commercial building, Load calculation and selection of size of service connection and nature of supply, Deciding the size of the cables, busbar and bus bar chambers, Mounting arrangements and positioning of switchboards, distribution boards main switch etc, Earthing of the electrical installation, Selection of type wire, wiring system and layout, Sequence to be followed to prepare estimate, Preparation of detailed estimate and costing of commercial installation.

Module IV: Service Connection, Inspection and Testing of Installation (7 Lectures)

Concept of service connection, Types of service connection and their features, Method of installation of service connection, Estimates of underground and overhead service connections, Inspection of internal wiring installations, Inspection of new installations, testing of installations, testing of wiring installations, Reason for excess recording of energy consumption by energy meter.

Electrical Installation For Power Circuits: Introduction, Important considerations regarding motor installation wiring, Determination of input power, Determination of input current to motors Determination of rating of cables

Determination of rating of fuse, Determination of size of Condit, distribution Board main switch and starter.

Module V: Design & Estimation of Overhead Transmission & Distribution Lines (10 Lectures)

Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps,Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Conductor erection, Repairing and jointing of conductor , Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Tee-offs, Earthing of transmission lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between conductors, Testing and commissioning of overhead distribution lines, Some important specifications.

Module VI: Design and Estimation of Substations (6 Lectures)

Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and

location of site for substation, Main Electrical Connections, Graphical symbols for various types of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply, Substation Earthing.

Suggested Readings:

[1]. Raina K.B. and Bhattacharya S.K., "Electrical Design, Estimating and Costing", New Age International, New Delhi, 2010

[2]. N. Alagappan & S. Ekambaram, "Electrical Estimating & Costing", TMH,2006

[3]. Dr.S.L.Uppal, "Electrical Wiring, Estimating and Costing", 5th Edition, Khanna Publishers,2003.

[4]. M.V. Deshpande, "Elements of Electrical Power Station Design", PHI 2009.

[5]. J. B. Gupta, "A Course in Electrical Installation Estimating and Costing", S. K. Kataria and Sons, India,2013.

[6]. ISI, National Electric Code, Bureau of Indian Standard Publications, New Delhi, 2011.

EE612 **Electrical Engineering Materials**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, the students will be able to:

CO's	CO Description
CO1	**Understand** various types of dielectric materials, their properties in various conditions.
CO2	**Evaluate** magnetic materials and their behavior.
CO3	**Evaluate** semiconductor materials and technologies.
CO4	**Acquire** Knowledge on Materials used in electrical engineering and applications.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Dielectric Materials

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

Module II: Magnetic Materials

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and hysteresis.

Module III: Semiconductor Materials

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

Module IV: Materials for Electrical Applications

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials,

thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

Module V: Special Purpose Materials

Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

Suggested Readings:

[1]. "R K Rajput", " A course in Electrical Engineering Materials", Laxmi Publications, 2009

[2]. "T K Basak", " A course in Electrical Engineering Materials", New Age Science Publications 2009

Reference Books:

[1]. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.

[2]. "AdrianusJ.Dekker", Electrical Engineering Materials, PHI Publication, 2006.

[3]. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.

EE613 **Power System Restructuring**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO1	**Understand** the developments of restructuring worldwide.
CO2	**Identify** the roles and responsibilities of different entities in power market.
CO3	**Identify** issues like congestion management Ancillary Services Management.
CO4	**Evaluate** the transmission pricing schemes
CO5	**Explain** the Ancillary Services Management and the reforms in Indian power sector

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	2	1	1								2
CO2	1	2	1	2		1						2
CO3	2	2	1	2		1			2			2
CO4	1	1	1	2					1			2
CO5	2	2	1	1								2
Avg.	**1.4**	**1.75**	**1.0**	**1.6**		**1**			**1.5**			**2**

DETAILED SYLLABUS

Module I: Introduction to Restructuring of Power Industry (8 Lectures)

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models.

Module II: Electricity Market Model (8 Lectures)

Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading.

Module III: Transmission Congestion Management (8 Lectures)

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion Management.

Module IV: Locational Marginal Prices and Financial Transmission Rights (5 Lectures)

Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights.

Module – V: Transmission Pricing Schemes (7 Lectures)

Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation.

Module – VI: Ancillary Service Management (4 Lectures)

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service.

Module-VII: Reforms in Indian Power Sector (2 Lectures)

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

Suggested Readings:

[1]. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001.

[2]. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.

[3]. Leo Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology" Wiley Pub. November 2001.

[4]. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.

Reference Books:

[1]. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002.

[2]. Marija llic, Francisco Galiana and Lestor Fink , Power System Restructuring Engineering & Economics , Kulwer Academic Publisher, USA-2000.

EE614 **Green Energy Technology**

L	T	Credit
3	1	3

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **realize** their importance in today's scenario.
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system.
CO3	**Understand** the concept behind the bio-mass, geothermal, tidal, ocean thermal and wave energy conversions.
CO4	**Outline** the basics of fuel cells and hydrogen production and storage.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	2	1	1	1	1		1					1
CO4	2	1	1	1	1		1					1
Avg.	**2.5**	**1.25**	**1.33**	**1.25**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(4 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(10 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(5 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Tidal, Wave and Ocean energy (6 Lectures)

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC.

Module VI: Emerging technologies for power generation (5 Lectures)

Fuel cells, Principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Suggested Readings:

[1] Non-Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

[2] D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.

[3] Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997

[4] S. P. Sukhatme, Solar Energy, TMH, India. 2008.

[5] Introduction to Wind Energy Systems: Basics, Technology and Operation (Green Energy and Technology), by Hermann-josef Wagner, ISBN: 9783642020223, Publisher: Springer, September 2009.

[6] Biofuels - Securing the Planet's Future Energy Needs, Edited by A Demirbas Springer 2009

[7] Fuel Cells: The Sourcebook - New Edition 2004 Escovale 2004.

Reference Books:

[1] John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.

[2] Renewable Energy, Third Edition, Bent Sorensen, Academic Press August 2004

[3] Wind Energy Explained: Theory, Design and Application, by J. F. Manwell, ISBN: 9780470015001, Publisher: John Wiley & Sons, Publication Date: February 2010 .

[4] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Open Elective-II
(Any One)

EE621

Advanced Control Systems*

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction (8 Lectures)

Introduction to digital control system, Examples of Data control systems, Sampler, Sampling Theorem, Data Reconstruction: Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: Modeling discrete-time systems by pulse transfer function (8 Lectures)

Revisiting Z-transform: Introduction to Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations. Mapping of S-plane to Z-plane, Pulse transfer function, Pulse transfer function of closed loop system, sampled signal flow graph

Module III: State Space Analysis (12 Lectures)

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and its Properties.

Discrete state space model: Introduction to state variable model, various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation.

Module IV: Controllability, Observability & Stability (8 Lectures)

Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability. Stability analysis of discrete time systems: Jury stability

test Stability analysis using Bi-linear transformation.

Module V: State Feedback Controller **(6 Lectures)**

Design of state feedback controller through pole placement – Necessary and sufficient conditions. Observer: Full Order Observer, Reduced Order Observer. Lyapunov Stability Theorem.

Suggested Readings:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition

[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.

[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

EE622 **Soft Computing Techniques**

L	T	Credit
3	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO1	**Distinguish** the concept between the hard and soft computing techniques.
CO2	**Understand** the basic concept of the Artificial Neural Network (ANN).
CO3	**Understand** the basic concept of the fuzzy logic system
CO4	**Explain** the concept of Genetic Algorithm (GA) and its limitation.
CO5	**Choose** the different kind of evolutionary programming for multi objective optimization problem based on their application.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	2	2							2
Avg.	**3**	**3**	**3**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Fundamentals of Soft Computing Techniques (4 Lectures)

Conventional and Modern Control System, Intelligence, Soft and Hard Computing, Artificial Intelligence.

Module-II: Artificial Neural Network (10 Lectures)

Introduction to Artificial neural networks-biological neurons, Basic models of artificial neural networks- Connections, Learning, Activation Functions, McCulloch and Pitts Neuron.

Learning rule- Hebbian Learning, Perceptron Learning, Delta Learning- Training and Testing algorithm, Adaptive Linear Neuron, Back Propagation Network – Architecture, Training algorithm.

Module-III: Fuzzy Logic System-I (8 Lectures)

Fuzzy Logic- Fuzzy sets- Properties- Operation on fuzzy sets, fuzzy relations- operations on fuzzy relations.

Fuzzy membership functions, fuzzification, Methods of membership value assignments- intuition- inference- rank ordering, Lambda- cuts for fuzzy sets, Defuzzification methods.

Module –IV: Fuzzy Logic System-II (7 Lectures)

Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules – Decomposition of rules- Aggregation of rules, Fuzzy Inference Systems- Mamdani and Sugeno types, Neuro-fuzzy hybrid systems – characteristics- classification

Module-V: (8 Lectures)

Introduction to genetic algorithm, operators in genetic algorithm – coding – selection – cross over – mutation, Stopping condition for genetic algorithm flow, Generational Cycle, Applications.

Module-VI: (5 Lectures)

Evolutionary Programming, Multi-objective Optimization Problem Solving and its applications, Genetic- neuro hybrid systems, Genetic-Fuzzy rule based system.

Suggested Readings:

[1]. N.P Padhy, Artificial Intelligence and Intelligent Systems- Oxford University Press.

[2]. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing- Wiley India.

[3]. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.

[4]. M.E. E1- Hawary , Artificial Intelligence application in Power Systems, IEEE Press,2009

[5]. Jan Jantzen, Foundations of Fuzzy Control, A practical approach, Wiley,2013

[6]. M Gopal, Digital Control and State Variable Methods, conventional and neural-fuzzy control system, Published by Tata McGraw Hill Education Private Ltd,2012

[7]. David E Goldberg, Genetic Algorithms, published by Pearson 2008

Reference Books:

[1]. Satish Kumar, Neural Networks- Prentice Hall of India.

[2]. N. K. Sinha and M.M. Gupta, Soft Computing and Intelligent Systems: Theory & Applications- Academic Press/ Elsevier, 2009.

[3]. Simon Haykin, Neural Network- A comprehensive Foundation- PHI, Inc.

[4]. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/ Elsevier, 2007.

EE623 **Power Electronics*** **L T Credit**

3 1 3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and it's various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices (10 Lectures)

Power Diode, BJT, MOSFET, IGBT, Thyristor, GTO: constructional features, I-V Characteristics, switching Characteristics, Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters (8 Lectures)

Introduction, Single-phase half-wave and full-wave rectifiers with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter (6 Lectures)

Introduction, Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, quadrant operation of chopper. power circuit of a buck, boost and buck-boost converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module IV: Single-Phase Voltage Source Inverter (6 Lectures)

Introduction, Single-phase voltage source inverter, operation and analysis, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage. Current source inverter.

Module V: Three-Phase Voltage Source Inverter (6 Lectures)

Three-phase voltage source inverter, operation and analysis, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation.

Module VI: AC Voltage Controllers (6 Lectures)

Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Suggested Readings:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.

[2]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[3]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.

[4]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

EE624 **Mine Electrical Engineering*** **L T Credit**

3 1 3

Pre-requisite: Basic Electrical Engineering and Basic Electronics Engineering.

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** different types of power supply systems and protection schemes used underground coal mines.
CO2	**Understand** different types of circuit breakers and relay used in Mines.
CO3	**Analyze** illumination, Intrinsically Safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications in mines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1		1						2
CO2	3	3	2	1		1						2
CO3	3	3	2	1		1						2
CO4	3	3	2	1		1						2
CO5	3	3	12	1		1						2
Avg.	**3**	**3**	**2**	**1**		**1**						**2**

DETAILED SYLLABUS

Module I:

Types of electrical power supply systems for underground coal mines – solidly earthed, restricted neutral and insulated – neutral systems of electrical power supply; their comparisons.

Module II:

Earth fault protection techniques for above mine power supply systems, sensitive and fail-safe earth fault relays. On-line insulation monitoring for insulated-neutral electrical distribution system.

Module III:

Mining type circuit breakers – Air circuit breaker, vacuum and Hexa Sulfa Flouride (Sf6) circuit breakers, Field switch, Tran switch Unit, Gate End Box, Drill Panel.

Module IV:

Electrical power planning for mechanized longwall faces – general scheme of electrical power distribution, voltage drop problems and remedial measurers; Inbye substation capacity selection. General scheme of electrical power distribution in opencast projects, Quarry substation capacity selection. Choice of restricted-neutral and insulated-neutral systems in open cast mines.

Module V:

Illumination planning for mines – underground roadway lighting system; intrinsically-safe lighting system for longwall faces, opencast mine lighting. Unit-VI Earthing practice in mines – earth pits, earthing of mobile electrical equipment in mines. Mining cables – types, constructional details; layout of cables through shaft and other locations.

Module VI:

Principles of flame proof enclosures. Intrinsically safe circuit methods of attaining intrinsic safety, zeener safety barriers and their applications. Indian electricity rules as applied to mines.

Suggested Readings:

[1] A Text Book on Power Systems Engineering – Soni Gupta, Bhatnagar, Chakarbarti, Dhanpat Rai & Sons.

[2] Electrical Equipment in mines- H. Cotton.

[3] Switchgear and Protection- S.S. Rao Khanna Publications.

[4] Indian Electricity Rules.

[5] Principles of Mine Planning J. Bhattacharya, Allied Publications.

Reference Books:

[1] Universal Mining School Series (UK)

[2] Coal Mining Practice- J.C. F Statharm Vol III, Heart Series.

[3] Electrical Power Systems – C.L. Wadhwa, New Age International Publishers

EE625

Green Energy Technology*

L	T	Credit
3	1	3

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **realize** their importance in today's scenario.
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system.
CO3	**Understand** the concept behind the bio-mass, geothermal, tidal, ocean thermal and wave energy conversions.
CO4	**Outline** the basics of fuel cells and hydrogen production and storage.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	2	1	1	1	1		1					1
CO4	2	1	1	1	1		1					1
Avg.	**2.5**	**1.25**	**1.33**	**1.25**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(4 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(10 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(5 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Tidal, Wave and Ocean energy (6 Lectures)

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC.

Module VI: Emerging technologies for power generation (5 Lectures)

Fuel cells, Principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Suggested Readings:

[1] Non-Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

[2] D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.

[3] Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997

[4] S. P. Sukhatme, Solar Energy, TMH, India. 2008.

[5] Introduction to Wind Energy Systems: Basics, Technology and Operation (Green Energy and Technology), by Hermann-josef Wagner, ISBN: 9783642020223, Publisher: Springer, September 2009.

[6] Biofuels - Securing the Planet's Future Energy Needs, Edited by A Demirbas Springer 2009

[7] Fuel Cells: The Sourcebook - New Edition 2004 Escovale 2004.

Reference Books:

[1] John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.

[2] Renewable Energy, Third Edition, Bent Sorensen, Academic Press August 2004

[3] Wind Energy Explained: Theory, Design and Application, by J. F. Manwell, ISBN: 9780470015001, Publisher: John Wiley & Sons, Publication Date: February 2010 .

[4] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Laboratory/ Sessional

EE601P		P	Credit
	Power Systems-II Laboratory		
		3	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Any 10 experiments out of which atleast 7 experiments from Group-A and 3 experiments from Group-B.

Group-A: SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)

1) Formation of Bus admittance matrix
2) Solution of load flow problem using Gauss-Seidel method
3) Solution of load flow problem using Newton-Raphson method.
4) Solution of load flow problem using Fast Decoupled Method
5) Formation of Z-bus matrix
6) Application of Swing equation and its solution to determine transient stability
7) Simulation of LFC for two area power system
8) Economic load dispatch without considering network losses
9) Economic load dispatch considering network losses
10) To perform symmetrical fault analysis in a power system

Group B: HARDWARE BASED

1) To determine negative and zero sequence synchronous reactance of an alternator.
2) To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
3) To determine location of fault in a cable using cable fault locator
4) Determination of power angle characteristics of an Alternator

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE602P		P	Credit
	Power Electronics Laboratory		
		3	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To study 1-phase half wave and full wave mid-point uncontrolled rectifier
2) To study 1-phase half wave and full wave bridge controlled rectifier.
3) Study of three-phase half & fully wave controlled bridge converter with R and RL load.
4) To study V-I characteristics of SCR.
5) Study of AC voltage controller using TRIAC with R and RL load.
6) To study different triggering circuits for thyristors.
7) To study the operation of buck converter.
8) To study the operation of boost converter.
9) To study the function of Inverter trainer
10) To study class A and Class B commutation circuit.
11) To study class C and class D commutation circuit
12) To study the single phase cycloconverter with R and R-L Loads.
13) To study the operation of single phase dual converter fed PMDC motor
14) To determine speed vs load characteristics of BLDC motor.
15) To perform speed control of 3-phase induction motor using v/f control method

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE603P	Simulation Laboratory	P	Credit
		3	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

These experiments can be performed using any software / FOSS (Free and Open Source Software) available at the institute.

1) Simulation of Single Phase Half Wave Uncontrolled Rectifier with R and RL-Load.
2) Simulation of Single Phase Half Wave Controlled Rectifier with R and RL-Load.
3) Simulation of Single Phase Semi Controlled Rectifier with R and RL-Load.
4) Simulation of Single Phase Full Wave Uncontrolled Rectifier with R and RL- Load.
5) Simulation THD Analysis of Single Phase Full Wave Controlled Rectifier with R and RL-Load.
6) Simulation and THD Analysis of Single Phase Full Wave Rectifier with RLE-Load.
7) Simulation and THD Analysis of Three Phase Half Wave Rectifier using R and RL-Load.
8) Simulation and THD Analysis of Three Phase Full Bridge Converter using R and RL-Load.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE604P		P	Credit
	Electrical Workshop		
		3	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To study the different types of cable and conductors.
2) To perform house wiring for bulb, fan and a 3-pin socket.
3) To study the different types of motor starters.
4) To perform and verify the connection of fluorescent lamp, circuit, lines.
5) To Study Institute Substation.
6) Determination of dielectric strength of the given transformer oil.
7) To study different components of CT & PT.
8) To measure the resistance by using earth resistance tester.
9) To study of lap, wave, short pitch winding in machine.
10) To measure insulation resistance of 3 - induction motor.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.