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 3** | **T 1** | **Credit 3**

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 **Power Plant Engineering**

L	T	Credit
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	Industrial Instrumentation And Automation	L	T	Credit
		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).

<u>List of the Experiments</u>

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	Principles of Control System 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) 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	**Microprocessor & Microcontroller 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.

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	**Basic Computational 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) 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.