Second Year Engineering

Third Semester

		Theory				Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Network Theory	3-0	3	100	50	2	1	50
PC	Analog Electronics Circuit	3-0	3	100	50	2	1	50
PC	Electrical Machines I	3-0	3	100	50	2	1	50
PC	Electrical & Electronics Measurement	3-0	3	100	50	2	1	50
PC	Electromagnetic Theory	3-1	4	100	50			
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
Total		19	19	600	300	8	4	200
Total Marks: 1100								
Total Credits: 23								
Honors Paper	Electrical Engineering Materials	4	4	100	50			
Minor Specialization	Electrical & Electronics Measurement/ Electromagnetic Theory							

Semester : 3rd

1.	PEE3D001	Honours(CP)	Electrical Engineering Materials	4-0-0	4
2.	PEK3E001	HS(O1)	Engineering Economics	3-0-0	3
3.	POB3E002	HS(O1)	Organizational Behavior	3-0-0	3
4.	PEE3G001	Minor(O3)	Electrical and Electronics Measurement	4-0-0	4
5.	PEE3G002	Minor(O3)	Electromagnetic Theory	4-0-0	4
6.	PEE3I001	PC(CP)	Electromagnetic Theory	4-0-0	4
7.	PEE3I101	PC(CP)	Network Theory	3-0-1	4
8.	PEE3I102	PC(CP)	Analog Electronic Circuits	3-0-1	4
9.	PEE3I103	PC(CP)	Electrical Machines - I	3-0-1	4
10.	PEE3I104	PC(CP)	Electrical & Electronics Measurement	3-0-1	4

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PEE3I101 NETWORK THEORY

Module- I **[11 Hours]**

University Portion (80%)

Network Theorems: Superposition theorem, Thevenin's theorem, Norton's Theorem, Reciprocity Theorem, Maximum Power transfer theorem, Tellegen's theorem, Millman's theorem, Compensation theorem.Coupled Circuits: Coupled Circuits, Dot Convention for representing coupled circuits, Coefficient of coupling.

Resonance: Band Width and Q-factor for series and parallel resonant circuits.

College/Institute Portion (20%):

Electrical equivalent of magnetically Coupled Circuit, Tuned Couple Circuit: Single tuned and double tuned or related advanced topics as decided by the concerned faculty teaching the subject.

Module- II **[9 Hours]**

University Portion (80%)

Laplace Transform & its Application: Introduction to Laplace Transform, Laplace transform of some basic functions, Laplace transform of periodic functions, Inverse Laplace transform, Application of Laplace transform: Circuit Analysis (Steady State and Transient).

Two Port Network Functions& Responses: z, y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks.

Network Functions: Significance of Poles and Zeros, Restriction on location of Poles and Zeros, Time domain behavior from Pole-Zero plots.

College/Institute Portion (20%):

Necessary conditions for transfer function, natural response of a network, Routh Hurwitz criterion of stability of network function or related advanced topics as decided by the concerned faculty teaching the subject.

Module- III **[5 Hours]**

University Portion (80%)

Fourier Series& its Application: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions.

Passive Filter: Brief idea about network filters (Low pass, High pass, Band pass and Band elimination) and their frequency response

College/Institute Portion (20%):

Active filter-Butterworth, Chebyshev filter or related advanced topics as decided by the concerned faculty teaching the subject.

Module- IV **[5 Hours]**

University Portion (80%)

Network Synthesis: Realizability concept, Hurwitz property, positive realness, properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions in Foster and Cauer forms.

College/Institute Portion (20%):

Network Topology: Graph of a network, Concept of tree, Incidence matrix, Tie-set matrix, Cut-set matrix, Formulation and solution of network equilibrium equations on loop and node basis, Dual of a network or related advanced topics as decided by the concerned faculty teaching the subject.

Text Book:

1. *Fundamentals of Electric Circuits – Alexander & Sadiku – Tata McGraw Hil,5th Editionl.*
2. *Circuits & Networks: Analysis, Design and Synthesis- Sukhija & Nagsarkar- Oxford*

Reference Book(s):

1. *Network Analysis – M E Van Valkenburg – Pearson Education, 3rd Edition.*
2. *Network Synthesis – M E Van Valkenburg – Pearson Education.*
3. *Network Analysis and Synthesis – Franklin F. Kuo – Wiley Student Edition.*
4. *Linear Circuits Analysis and Synthesis – A Ramakalyan – Oxford University Press.*
5. *Problems & Solutions in Electric Circuit Analysis – Sivananda & Deepa – Jaico Book.*
6. *Theory and problem of electrical circuits, Schaum's Outline Series, TMH – Joseph A. Edminister, MahmoodMaqvi.*
7. *Electric Circuits – David A.Bell – Oxford, 7th Edition, 2015.*

NETWORK THEORY LAB

Select any 8 experiments from the list of 10 experiments

1. *Verification of Network Theorems using AC circuits. (Superposition, Thevenin, Norton, Maximum Power Transfer).*
2. *Study of DC and AC Transients for R-L, R-C & R-L-C circuits using storage oscilloscope.*
3. *Determination of circuit parameters: Open Circuit and Short Circuit parameters.*
4. *Determination of circuit parameters: Hybrid and Transmission parameters.*
5. *Frequency response of Low pass and High Pass Filters.*
6. *Frequency response of Band pass and Band Elimination Filters.*
7. *Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.*
8. *Study of resonance in R-L-C series circuit using oscilloscope.*
9. *Study of resonance in R-L-C parallel circuit using oscilloscope.*
10. *Spectral analysis of a non-sinusoidal waveform.*

PEE3I102 ANALOG ELECTRONICS CIRCUIT

MODULE – I **(12 Hours)**

MOS Field-Effect Transistor: Principle and Operation of FETs and MOSFETs; P-Channel and N-Channel MOSFET; Complimentary MOS; V-I Characteristics of E- MOSFET and D-MOSFET; MOSFET as an Amplifier and as a Switch. (4 Hours)

Biasing of BJTs: Load lines (AC and DC); Operating Points; Fixed Bias and Self Bias, DC Bias with Voltage Feedback; Bias Stabilization; Examples. (4 Hours)

Biasing of FETs and MOSFETs: Fixed Bias Configuration and Self Bias Configuration, Voltage Divider Bias and Design (4 Hours)

MODULE – II **(12 Hours)**

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Models; Small Signal Analysis of CE, CC, CB amplifiers. Effects of R_S and R_L on CE amplifier operation, Emitter Follower; Cascade amplifier, Darlington Connection and Current Mirror Circuits.

(6 Hours)

Small Signal Analysis of FETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifiers. Effects of R_{SIG} and R_L on CS Amplifier; Source Follower and Cascaded System.

(6 Hours)

MODULE – III **(5 hours)**

High Frequency Response of FETs and BJTs: High Frequency equivalent models and frequency Response of BJTs and FETs; Frequency Response of CS Amplifier, Frequency Response of CE Amplifier. (5 Hours)

MODULE – IV (9 hours)

Feedback amplifier and Oscillators: Concepts of negative and positive feedback; Four Basic Feedback Topologies, Practical Feedback Circuits, Principle of Sinusoidal Oscillator, Wein-Bridge, Phase Shift and Crystal Oscillator Circuits. (4 Hours)

Operational Amplifier: Ideal Op-Amp, Differential Amplifier, Op-Amp Parameters, Non-inverting Configurations, Open-loop and Closed-loop Gains, Differentiator and Integrator, Instrumentation amplifier. (5Hours)

Text Books

1. *Electronic Devices and Circuits theory, R.L. Boylestad and L. Nashelsky, Pearson Education, New Delhi , 9th/10th Edition,2013. (Selected portions of Chapter 4, 5, 6, 7, 8, 9, 10, 11, 12, and 14)*
2. *Milliman's Electronics Devices and Circuits, J. Milliman, C. Halkias, S. Jit., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2nd Edition,2008.*

Reference Books

1. *Microelectronics Circuits, Adel Sedra and Kenneth C Smith, Oxford University Press, New Delhi, 5th Edition, International Student Edition,2009. (Selected portion of Chapter 2,4, 5, 6, 8, 13, and 14)*
2. *Electronic Devices and Circuits, Jimmie J. Cathey adapted by Ajay Kumar Singh, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, (For Problem Solving)*
3. *Electronics Circuits Analysis and Design, Donald A. Neamen, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition,2002.*
4. *Integrated Electronics: Analog and Digital Circuits and Systems, J. Milliman, C. Halkias, Tata McGraw Hill Publishing Company Ltd., New Delhi,2nd Edition.2004.*
5. *Microelectronic Circuits: Analysis and Design, M.H. Rashid, PWS Publishing Company, a division of Thomson Learning Inc. India Edition.*
6. *Electronic device and circuits, David A. Bell, Oxford University Press, 5thedition,2008.*
7. *Electronics devices and circuits, Anil.K.Maini, Wiley India Pvt.Ltd,2009*

ANALOG ELECTRONICS CIRCUIT LAB

List of Experiments

(At least 10 out of 12 experiments should be done)

1. Design and simulate BJT bias circuit and compare the results.
2. *Design and simulate JEET/MOSFET bias circuit and compare the results.*
3. *Design and simulate BJT common-emitter circuit and compare D.C and A.C performance:*
4. *Design and simulate JFET/MOSFET common-emitter circuit and compare D.C and A.C performance:*
5. *Determining the frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response and compare with simulated results.*
6. *Differential amplifiers circuits: D.C bias and A.C operation without and with current source.*
7. *Study of Darlington connection and current mirror circuits.*
8. *OP-Amp Frequency Response and Compensation.*
9. *Application of Op-Amp as differentiator, integrator, square wave generator.*
10. *Obtain the band width of FET/ BJT using Square wave testing of an amplifier.*
11. *R.C phase shift oscillator/Wien-Bridge Oscillator using OP-Amp/Crystal Oscillator.*
12. *Class A and Class B Power Amplifier.*

PEE3I103 ELECTRICAL MACHINES- I

Module- I

University Portion (80%):

Single phase transformers: Phasor Diagrams at No -Load and Load Conditions of an Ideal transformer and practical transformer, Equivalent Circuit, Determination of Parameters from Tests (Polarity Test, Open Circuit Test and Short Circuit Test, Back to Back test), Per Unit Calculation and its importance, Voltage Regulation, Losses, Efficiency and all day efficiency. Parallel operation of transformers and load sharing.

Auto Transformer:Basic constructional features; VA conducted magnetically and electrically. Comparative study with two winding transformer. Conversion of a two winding transformer into a single winding transformer.

Module- II

University Portion (80%):

Three phase transformers: Constructional features, As a single unit and as a bank of three single phase transformers. Three-Phase Transformer connections, The per unit system for Three Phase Transformer, Transformer Ratings and Related problems, Two Single-Phase Transformers connected in Open Delta (V-Connection) and their rating. T-Connection (Scott Connection) of Two Single-Phase Transformers. Transformer Three phase Connections: Various Phase Displacements (0o, 180o, +30o and -30o), Connection Diagrams and Phasor Diagrams of various Vector Groups (Yy0, Dd0, Dz0, Yy6, Dd6, Dz6, Yd1, Dy1, Yz1, Yd11, Dy11, and Yz11)

Module- III

University Portion (80%):

Three phase induction machines:Constructional features and types; 3-phase distributed winding production of rotating magnetic field, Principle of Operation, The Effect of Coil Pitch and distribution factor on A.C. Machines, winding factor, Concept of Slip, Slip Speed; Phasor diagram and Development of equivalent circuit and derivation of torque equation; Typical torque-slip characteristic and influence of different parameters on it, No-Load and Blocked Rotor tests, Determination of Parameters, power flow diagram, Losses and Efficiency, Methods of starting and speed control. Cogging, Crawling.

Module- IV

University Portion (80%):

Single phase induction machines: Double field revolving theory, Methods of starting using auxiliary winding, development of equivalent circuit. No-Load and Blocked Rotor tests, Determination of Parameters Speed Control of Single Phase Induction Motors.

Text Book:

1. *Theory and Performance of AC Machines – M G Say*
2. *Electric Machinery – Fitzgerald, Charles Kingsley Jr., S. D. Umans – Tata Mc Graw Hill.*

Reference Book(s):

1. *Electrical Machinery – P S Bimbhra – Khanna Publishers*
2. *The Performance and Design of DC Machines – A E Clayton.*
3. *Electric Machines – D P Kothari and I J Nagrath – Tata McGraw Hill, Fourth Edition.*
4. *Electric Machines – Charles Hubert – Pearson Education.*
5. *Electrical Machines – P K Mukherjee and S Chakravorti – Dhanpat Rai Publications.*
6. *Electric Machinery and Transformers – Guru & Hiziroglu – Oxford University Press.*

ELECTRICAL MACHINES LAB-I

Select any 8 experiments from the list of 10 experiments

1. *Determination of Efficiency and Voltage Regulation by Open Circuit and Short Circuit test on single phase transformer.*
2. *Parallel operation of two single phase transformers.*
3. *Back-to Back test on two single phase transformers.*
4. *Study of open delta and Scott connection of two single phase transformers.*
5. *Speed control of a three phase induction motor using variable frequency drives*
6. *Determination of parameters of three phase induction motor from No load Test and Blocked Rotor Test.*
7. *Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase Induction motor by Brake Test.*
8. *Performance of grid connected induction generator.*
9. *Determination of parameter of a single phase induction motor and study of*
   - *(a) Capacitor start induction motor*
   - *(b) Capacitor start and capacitor run induction motor*
   - *(c) Universal motor*
   - *(d) Shaded pole motor*

PEE3I104 ELECTRICAL AND ELECTRONICS MEASUREMENT

Module- I **[10 Hours]**

University Portion (80%): (8 Hours)

Measurement and Error: (2Hrs) Definition, Accuracy and Precision, Significant Figures, Types of Errors. Text book-2-Ch-[1.1 to 1.4]

Standards of Measurement: (1 Hrs) Classification of Standards, Electrical Standards, IEEE Standards. Text Book-2- Ch-[3.1,3.4,3.6]

Types of measuring instrument: (5 Hrs) Ammeter and Voltmeter: Derivation for Deflecting Torque of; PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction type Ammeters and Voltmeters. Energy meters and wattmeter.: Construction, Theory and Principle of operation of Electro-Dynamometer and Induction type wattmeter, compensation, creep, error, testing, Single Phase and Polyphase Induction type Watt-hour meters. Frequency Meters: Vibrating reed type, electrical resonance type, Power Factor Meters. Text Book-1- Ch- [XVIII,XIX,XX,XXI,XXII]

Module-II **[10 Hours]**

University Portion(80%): (8 Hours)

Measurement of Resistance, Inductance and Capacitance: (8 Hrs)

Resistance: Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance, Measurement of Resistance of Insulating Materials, Portable Resistance Testing set (Megohmmeter), Measurement of Insulation Resistance when Power is ON, Measurement of Resistance of Earth Connections.

Inductance: Measurement of Self Inductance by Ammeter and Voltmeter, and AC Bridges (Maxwell's, Hay's, & Anderson Bridge), Measurement of Mutual Inductance by Felici's Method, and as Self Inductance.

Capacitance: Measurement of Capacitance by Ammeter and Voltmeter, and AC Bridges (Owen's, Schering & Wien's Bridge), Screening of Bridge Components and Wagnor Earthing Device. Text Book-1- Ch-[VI, VII]

Module- III **[10 Hours]**

University Portion (80%): (8 Hours)

Galvanometer: (5 Hrs) Construction, Theory and Principle of operation of D'Arsonval, Vibration (Moving Magnet & Moving Coil types), and Ballistic Galvanometer, Influence of Resistance on Damping, Logarithmic decrement, Calibration of Galvanometers, Galvanometer Constants, Measurement of Flux and Magnetic Field by using Galvanometers.

Potentiometer: (3 Hrs) Construction, Theory and Principle of operation of DC Potentiometers (Crompton, Vernier, Constant Resistance, & Deflection Potentiometer), and AC Potentiometers (Drysdale-Tinsley & Gall-Tinsley Potentiometer). Text Book-1- Ch-[VIII,IX]

Module- IV **[10 Hours]**

University Portion(80%): (8 Hours)

Current Transformer and Potential Transformer :(3 Hrs) Construction, Theory, Characteristics and Testing of CTs and PTs.

Electronic Instruments for Measuring Basic Parameters:(2 Hrs) Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Considerations for choosing an Analog Voltmeter, Digital Voltmeters (Block Diagrams only), Q-meter

Oscilloscope:(3 Hrs) Block Diagrams, Delay Line, Multiple Trace, Oscilloscope Probes, Oscilloscope Techniques, Introduction to Analog and Digital Storage Oscilloscopes, Measurement of Frequency, Phase Angle, and Time Delay using Oscilloscope.

Text Book-2- Ch- [6.2 to 6.9, 7.2, 7.6, 7.7]

Text Book(s):

1. *Electrical Measurements and Measuring Instruments – Golding & Widdis – 5th Edition, Reem Publication.*
2. *Modern Electronic Instrumentation and Measurement Techniques – Helfrick & Cooper – Pearson Education.*

Reference Book(s):

1. *A Course in Electrical and Electronic Measurements and Instrumentation – A K Sawhney – Dhanpat Rai & Co.*
2. *Electronic Instrumentation – H C Kalsi – 2nd Edition, Tata McGraw Hill.*
3. *Electronic Measurement and Instrumentation – Oliver & Cage – Tata McGraw Hill.*
4.

ELECTRICAL AND ELECTRONICS MEASUREMENTLAB

Select any 8 experiments from the list of 10 experiments

1. *Measurement of Low Resistance by Kelvin's Double Bridge Method.*
2. *Measurement of Self Inductance and Capacitance using Bridges.*
3. *Study of Galvanometer and Determination of Sensitivity and Galvanometer Constants.*
4. *Calibration of Voltmeters and Ammeters using Potentiometers.*
5. *Testing of Energy meters (Single phase type).*
6. *Measurement of Iron Loss from B-H Curve by using CRO.*
7. *Measurement of R, L, and C using Q-meter.*
8. *Measurement of Power in a single phase circuit by using CTs and PTs.*
9. *Measurement of Power and Power Factor in a three phase AC circuit by two-wattmeter method.*
10. *Study of Spectrum Analyzers.*

PEE3I001 ELECTROMAGNETIC THEORY

Module – I **[8 Hours]**

University Portion (80%):

Co-ordinate systems & Transformation: Cartesian co-ordinates, circular cylindrical co-ordinates, spherical co-ordinates.

Vector Calculus: Differential length, Area & volume, Line surface and volume Integrals, Del operator, Gradient of a scalar, Divergence of a vector & divergence theorem, curl of a vector & Stoke's theorem, laplacian of a scalar (Text Book 1: Chapter- 1, Chapter-2)

Module – II **[11 Hours]**

University Portion (80%):

Electrostatic Fields: Coulomb's Law, Electric Field Intensity, Electric Fields due to point, line, surface and volume charge, Electric Flux Density, Gauss's Law – Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship between E and V –Maxwell's Equation An Electric Dipole & Flux Lines, Energy Density in Electrostatic Fields., Electrostatic Boundary – Value Problems: Possion's & Laplace's Equations, Uniqueness theorem, General procedures for solving possion's or Laplace's Equation. (Textbook-1: Chapter- 3, 4, 5.1 to 5.5)

Module – III **[8 Hours]**

University Portion (80%):

Magnatostatic Fields: Magnetic Field Intensity, Biot-Savart's Law, Ampere's circuit law-Maxwell Equation, applications of Ampere's law, Magnetic Flux Density-Maxwell's equations. Maxwell's equation for static fields, Magnetic Scalar and Vector potentials. (Textbook-1: Chapter- 6.1 to 6.8)

Module – IV **[7 Hours]**

University Portion (80%):

Electromagnetic Fields and Wave Propagation: Faraday's Law, Transformer & Motional Electromagnetic Forces, Displacement Current, Maxwell's Equation in Final forms, Time Varying Potentials, Time-Harmonic Field. Electromagnetic Wave Propagation: Wave Propagation in lossy Dielectrics, Plane Waves in loss less Dielectrics, Power & pointing vector. (Textbook-1: Chapter-8.1 to 8.7, Ch.9.1 to 9.3 & 9.6)

Text Book:

1. *Matthew N. O. Sadiku, Principles of Electromagnetics, 4th Ed., Oxford Intl. Student Edition.*

Reference Book:

2. *C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd, TMH.*
3. *W.H. Hyat, Electromagnetic Field Theory, 7th Ed, TMH.*

HONOUR SUBJECT

PEE3D001 ELECTRICAL ENGINEERING MATERIALS

Module – I **[14 Hours]**

Atomic bonding, crystallinity, Miller Indices, X-ray crystallorgraphy, structural imperfections, crystal growth. Free electron theory of metals, factors affecting electric conductivity of metals, thermal conductivity of metals, heat developed in current Carrying conductors, thermo electrice ffect, super conductivity.

Module – II **[10 Hours]**

Polarization mechanism and dielectric constant, behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization, piezoelectric effect. Origin of permanent magnetic dipoles in materials, classifications, diamagnetism, paramagnetism, ferromagnetism, Magnetic Anisotropy magnetostriction.

Module – III **[14 Hours]**

Energy band theory, classification of materials using energy band theory, Hall effect, drift and diffusion currents, continuity equation, P-N diode, volt-amp equation and its temperature dependence. Properties and applications of electrical conducting, semiconducting, insulating and magnetic materials.

Module – IV **[10 Hours]**

Special purpose materials, Nickel iron alloys, high frequency materials, permanent magnet materials, Feebly magnetic materials, Ageing of a permanent magnet, Effect of impurities, Losses in Magnetic materials.

Text Books:-

1. *J. Dekker, 'Electrical Engineering Materials', Prentice hall of India, India*
2. *S. Indulkar & S. Thiruvengadam, 'An introduction to Electrical Engineering Materials', S. Chand & Co., India*
3. *R. K. Rajput, 'Electrical Engineering Materials', Laxmi Publications, India*

Reference Books:-

1. *Ian P. Hones, 'Material Science for Electrical & Electronics Engineers', Oxford University Press*
2. *K. M. Gupta – Electrical Engineering Materials, Umesh Publication, 2nd edition 2003*

Fourth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
HS	Purely Applied Mathematics for Specific Branch of Engineering	3-0	3	100	50			
PC	Electrical Machines II	3-0	3	100	50	2	1	50
PC	Control System Engg I	3-0	3	100	50	2	1	50
PC	Digital Electronics Circuits	3-0	3	100	50	2	1	50
PC	Electrical Power Transmission & Distribution	3-0	3	100	50	2	1	50
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
	*Skill Project and Hands on					6	3	100
Total		18	18	600	300	14	7	300
Total Marks: 1200								
Total Credits: 25								
Honors	Sensors & Transducers (E&I)	4	4	100	50			
Minor	Electrical Power Transmission & Distribution / Control System Engineering-I							

Semester : 4th

1.	PEE4D001	Honours(CP)	Sensor & Transducers	4-0-0	4
2.	PEE4E001	HS(CP)	Purely Applied Mathematics for Specific Branch of Engineering	3-0-0	3
3.	PEK4E002	HS(O1)	Engineering Economics	3-0-0	3
4.	POB4E003	HS(O1)	Organizational Behavior	3-0-0	3
5.	PEE4G001	Minor(O3)	Electrical Power Transmission & Distribution	4-0-0	4
6.	PEE4G002	Minor(O3)	Control System Engineering - I	4-0-0	4
7.	PEE4I101	PC(CP)	Electrical Machines - II	3-0-1	4
8.	PEE4I102	PC(CP)	Control System Engineering - I	3-0-1	4
9.	PEE4I103	PC(CP)	Digital Electronic Circuits	3-0-1	4
10.	PEE4I104	PC(CP)	Electrical Power Transmission & Distribution	3-0-1	4
11.	PEE4I201	PC(CP)	Skill Project and Hands on	0-0-3	3
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PEE4I101 **ELECTRICAL MACHINES-II**

Module-I
University Portion (80%):
General principles of DC machines: Armature Windings (Simplex Lap and Simplex Wave), Expression for EMF Induced and Torque developed in the Armature counter Torque and Counter or Back EMF, Methods of Excitation, Armature Reaction, Commutation.
DC Machine Characteristics: Conditions for Self Excitation, Critical Resistance and Critical Speed. Internal and External Characteristics for self and Separately Excited DC Generator. Characteristic for Speed~ Armature Current, Torque~ Armature Current and Speed~ Torque of a DC Shunt, Series and Compound Motor and Comparison.

Module-II
University Portion (80%):
DC Motor Starting and Performance: Necessity of a Starter, Starting of DC Shunt, Series and Compound Motors, Speed Control of DC Shunt and Series motor Losses, efficiency and power flow diagram.
Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Internal Generated Voltage of a Synchronous Generator, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance).
Cylindrical Rotor type Three Phase Synchronous Generators: The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance, The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method
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Module-III
University Portion (80%):
Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactance, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of Direct axis and Quadrature axis Reactance.
Parallel operation of Three Phase A.C. Synchronous Generators.The Conditions Required for Paralleling, The General Procedure for Paralleling Generators, Frequency - Real Power and Voltage – Reactive Power Characteristics of a Three Phase Synchronous Generator.

Module-IV

University Portion (80%):

Three Phase Synchronous Motors: Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting Synchronous Motors, Synchronous Generators and Synchronous Motors, Operation of synchronous motors connected to bus and phasor diagrams for normal, under and over excited conditions, V and Λ curves, Synchronous Motor Ratings. Application.

Special Purpose Motors: The Universal series motor: constructional features and performance characteristics

Text books:

1. *Stephen J. Chapman-'Electric Machinery and Fundamentals'- Mc Graw Hill International Edition, (Fourth Edition), 2015.*
2. *M.G.Say-'Alternating Current Machines', English Language Book Society (ELBS)/ Longman , 5th Edition, Reprinted 1990.*

Reference books:

1. *B.S.Guru & H.R.Hiziroglu-'Electric Machinery & Transformers'-3rd Ed-Oxford Press, 2014.*
2. *P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, John Wiley and Sons, Wiley India Reprint, 2014.*
3. *A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition Mc Graw Hill – Reprint 2015.*
4. *D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition Mc Graw Hill – Reprint 2015.*
5. *P S Bimbhra – Electrical Machinery –Khanna Publishers.*

ELECTRICAL MACHINES LABORATORY-II

List of Experiment:

1. *Determination of critical resistance and critical speed from no load test of a DC shunt generator.*
2. *Plotting of external and internal characteristics of a DC shunt generator.*
3. *Speed control of DC shunt motor by armature voltage control and flux control method.*
4. *Determination of the voltage regulation of an alternator by synchronous impedance method and zero power factor (zpf) method*
5. *Determination of the V and inverted V curves of a synchronous motor*
6. *Determination of parameters of synchronous machine*
7. *Positive sequence reactance*
8. *Negative sequence reactance*
9. *Zero sequence reactance*
10. *Determination of power angle characteristics of an alternator*
11. *Study of parallel operation of two alternators*
12. *Measurement of direct and quadrature axis reactance of a salient pole synchronous machine*
13. *Measurement of transient and sub transient reactance of a salient pole alternator*

PEE4I102 **CONTROL SYSTEM ENGINEERING-I**

Module-I **[9 Hours]**

University Portion (80%):

Introduction to Control Systems: Basic Concepts of Control Systems, Open loop and closed loop systems, Servo Mechanism/Tracking System. (Text Book-1-Ch1)

Mathematical Models of Physical Systems: Differential Equations of Physical Systems, Transfer functions, Block Diagram Algebra, Signal flow Graphs. (Text Book-1-Ch 2.1, 2.2, 2.4 2.5 2.6)

Feedback characteristics of Control Systems: Feedback and Non-feedback System, Reduction of parameter variation by use of feedback, control over System Dynamics by use of feedback, Control of the Effects of disturbance signals by use of feedback, linearizing effect of feedback, regenerative feedback, Regenerative feedback.(Text Book-1-Ch 3.1 to 3.7)

Module-II **[9 Hours]**

University Portion (80%):

Time response Analysis: Standard Test Signals, Time response of first order systems, Time Response of Second order systems, Steady State Errors and Static Error Constants of different types of systems, Effect of adding a zero to a system, Design specification of second order system, Performance indices.
(Text Book-1-Ch- 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.9)

Concepts of Stability: The concept of stability, Necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Relative Stability Analysis, More on Routh Stability Criterion.
(Text Book-1 Ch-6.2, 6.3, 6.4, 6.5, 6.6)

The Root locus Technique: Introduction, Root locus Concepts, Construction of Root locus, Rout Contours, Systems with transportation lag. (Text Book-1-Ch- 7.1, 7.2, 7.3, 7.4, 7.5)

Module-III **[9 Hours]**

University Portion (80%):

Frequency Response Analysis: Correlation between Time and Frequency Response, Polar plots, Bode plots, All Pass and Minimum- Phase Systems. (Text Book-1-Ch- 8.2, 8.3, 8.4 8.5)

Stability in Frequency Domain: Mathematical Preliminaries, Nyquist Stability Criterion, Assessment of Relative stability using Nyquist Criterion, Closed loop Frequency Response, Sensitivity Analysis in Frequency Domain. (Text Book-1-Ch- 9.2, 9.3, 9.4, 9.5, 9.6

College/Institute Portion (20%):

Closed loop frequency response: Constant M circles, Constant N-Circles, Nichol's chart. (Text Book-2-Ch-)] Or any related topic as decided by the concerned faculty member teaching the subject.

Module-IV **[8 Hours]**

University Portion (80%):

State Variable Analysis: Introduction, Concepts of State, State Variables and State Model, Solution of State Equations, Concepts of Controllability and Observability. (Text Book-1-Ch-12.1, 12.2, 12.4, 12.6, 12.7)

Design Specifications of a control system: Proportional Derivative Error Control (PD Control), Proportional Integral Controller (PI Control), Proportional, Integral and Derivative Controller (PID Control), Derivative Output Control. (Text Book-3-Ch-3.7)

Text Books:

1. *Control Systems Engg. by I.J. Nagrath and M.Gopal, 5th Edition, New Age International Publishers (2010)*
2. *Modern Control Engineering by K. Ogata, 5th edition PHI.*
3. *Automatic Control Systems by Benjamin C. Kuo, 7th Edition, Prentice-Hall India publication (1995)*

Reference Books:

1. *Design of Feedback Control Systems by R.T. Stefani, B. Shahian, C.J. Savator, G.H. Hostetter, Fourth Edition (2009), Oxford University Press.*
2. *Control Systems (Principles and Design) by M.Gopal 3rd edition (2008), TMH.*
3. *Analysis of Linear Control Systems by R.L. Narasimham, I.K. International Publications*
4. *Control Systems Engineering by S.P. Eugene Xavier and J. Josheph Cyril Babu, 1st Edition (2004), S. Chand Co. Ltd.*
5. *Problems and solutions in Control System Engineering by S.N. Sivanandam and S.N. Deepa, Jaico Publishing House.*
6. *Modern Control Systems by Richard C.Dorf and Robert H. Bishop, 11th Ed (2009), Pearson.*

CONTROL SYSTEM LABORATORY

List of Experiments:

1. *Study of a dc motor driven position control system*
2. *Study of speed torque characteristics of two phase ac servomotor and determination of its transfer function*
3. *Obtain the frequency response of a lag and lead compensator*
4. *To observe the time response of a second order process with P, PI and PID control and apply PID control to servomotor*
5. *To determine the transfer function of a system (network) using transfer function analyser.*
6. *To study and validate the controllers for a temperature control system*
7. *To study the position control system using Synchroscope.*

4thSemester

PEE4I103 **DIGITAL ELECTRONICS CIRCUIT**

University Level:

MODULE – I (12 Hours)

Number System: Introduction to various number systems and their Conversion. Arithmetic Operation using 1's and 2`s Compliments, Signed Binary and Floating Point Number Representation Introduction to Binary codes and their applications. (**5 Hours)**
Boolean Algebra and Logic Gates: Boolean algebra and identities, Complete Logic set, logic gates and truth tables. Universal logic gates, Algebraic Reductionand realization using logic gates **(3 Hours)**
Combinational Logic Design: Specifying the Problem, Canonical Logic Forms, Extracting Canonical Forms, EX-OR Equivalence Operations, Logic Array, K-Maps: Two, Three and Four variable K-maps, NAND and NOR Logic Implementations. **(4 Hours)**

MODULE – II (14 Hours)

Logic Components: Concept of Digital Components, Binary Adders, Subtraction and Multiplication, An Equality Detector and comparator, Line Decoder, encoders, Multiplexers and De-multiplexers. **(5 Hours)**
Synchronous Sequential logic Design: sequential circuits, storage elements: Latches (SR, D), Storage elements: Flip-Flops inclusion of Master-Slave, characteristics equation and state diagram of each FFs and Conversion of Flip-Flops. Analysis of Clocked Sequential circuits and Mealy and Moore Models of Finite State Machines **(6 Hours)**
Binary Counters : Introduction, Principle and design of synchronous and asynchronous counters, Design of MOD-N counters, Ring counters. Decade counters, State Diagram of binary counters (4 hour)

MODULE – III (12 hours)

Shift resistors: Principle of 4-bit shift resistors. Shifting principle, Timing Diagram, SISO, SIPO ,PISO and PIPO resistors. (4 hour)
Memory and Programmable Logic: Types of Memories, Memory Decoding, error detection and correction), RAM and ROMs. Programmable Logic Array, Programmable Array Logic, Sequential Programmable Devices. **(5 Hours)**
IC Logic Families: Properties DTL, RTL, TTL, I^2L and CMOS and its gate level implementation. A/D converters and D/A converters **(4 Hours)**
Text book:

1. *Digital Design, 3rd Edition, Moris M. Mano, Pearson Education.*
2. *Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI*
3. *Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.*
4. *Digital Electronics, G K Kharate, Oxford University Press*

Reference Book:

1. *Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.*
2. *A First Course in Digital System Design: An Integrated Approach, India Edition, John P. Uyemura, PWS Publishing Company, a division of Thomson Learning Inc.*
3. *Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.*

DIGITAL ELECTRONICS CIRCUIT LAB

List of Experiments:

(At least 10 experiments should be done, Experiment No. 1 and 2 are compulsory and out of the balance 8 experiments at least 3 experiments has to be implemented through both Verilog /VHDL and hardware implementation as per choice of the student totaling to 6 and the rest 2 can be either through Verilog /VHDL or hardware implementation.)

1. *Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert and Buffer gates, use of Universal NANDGate.*
2. *Gate-level minimization: Two level and multi level implementation of Booleanfunctions.*
3. *Combinational Circuits: design, assemble and test: adders and subtractors, code converters, gray code to binary and 7 segmentdisplay.*
4. *Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) using minimum number ofGates.*
5. *Design with multiplexers andde-multiplexers.*
6. *Flip-Flop: assemble, test and investigate operation of SR, D & J-Kflip-flops.*
7. *Shift Registers: Design and investigate the operation of all types of shift registers with parallelload.*
8. *Counters: Design, assemble and test various ripple and synchronous counters - decimal counter, Binary counter with parallelload.*
9. *Memory Unit: Investigate the behaviour of RAM unit and its storage capacity – 16 X 4 RAM: testing, simulating and memoryexpansion.*
10. *Clock-pulse generator: design, implement andtest.*
11. *Parallel adder and accumulator: design, implement andtest.*
12. *Binary Multiplier: design and implement a circuit that multiplies 4-bit unsigned numbers to produce a 8-bitproduct.*
13. *Verilog/VHDL simulation and implementation of Experiments listed at Sl. No. 3 to 12*

PEE4I104 ELECTRICAL POWER TRANSMISSION & DISTRIBUTION

Module-1 **[13 Hours]**

University portion (80%)

Line Constant Calculations: Introduction to per unit system and calculation for transmission system. Magnetic flux Density, Inductors and Inductance Magnetic field Intensity due to long current carrying conductors, Inductance of two wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Inductance of double circuit three phase line, Concept of GMD, Bundled conductors, Skin and Proximity effect.

Capacitance of Transmission Lines: Electric Field of a Line of charge, Straight Conductor, The Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Capacitance of a double circuit line, Inductance of three phase un-symmetrically spaced transmission, Effect of Earth on the Capacitance of conductors.

Module-2 **[10 Hours]**

University portion (80%)

Performance of Lines: Representation of Lines, Short Transmission Lines, The Medium Transmission Lines, The Long Transmission Line: The Long Transmission Line, ABCD constants, Ferranti Effect Hyperbolic Form of The Equations, The Equivalent Circuit of a Long Line, Power Flow Through Transmission Line, Reactive Compensation of Transmission Line. Series and shunt compensation.

Module-3 **[10 Hours]**

University portion (80%)

Overhead Line Insulators: Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String, Methods of Equalizing the potential

Mechanical Design of Overhead Transmission Lines: The catenary curve, Sag Tension calculation, supports at different levels, Stringing chart, sag Template, Equivalent span, Stringing of Conductors, Vibration and Vibration Dampers

Distribution: Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law, General Design Considerations

Module-4 **[6 Hours]**

University portion (80%)

Insulated Cables: The Insulation, Extra High Voltages Cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core Cables, Heating of cables, Current rating of cables, Overhead lines Vs Underground Cables, Types of cable

Power System Earthing: Soil Resistivity, Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing Grid.

Text books:

1. *Power System Analysis- By John J. Grainger & W. D. Stevenson, Jr, Tata Mcgraw-Hill, 2003 Edition, 15th Reprint, 2010.*

Reference books:

2. *Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., 2008 Wiley India.*
3. *Electrical Power Systems-C.L.Wadhwa, New Age International Publishers, Sixth Edition.*
4. *Power System Analysis & Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003.*

ELECTRICAL POWER TRANSMISSION & DISTRIBUTION LAB

1. *Study and of Ferranti Effect.*
2. *Determination of ABCD Parameter.*
3. *Determination of string efficiency.*
4. *Earth resistance measurement.*
5. *Series and shunt capacitance computation in transmission line.*
6. *Transformer oil test.*
7. *Study of various lightning arresters.*
8. *Distribution system power factor improvement using switched capacitor.*
9. *Study of corona discharge.*

PEE4D001 **SENSORS AND TRANSDUCERS**

Module -1[9 Hours]
University Portion (80%): (8 Hours)
Elements of a general measurement system: Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. (Bentley: Chapters 1-4)

Module-2 [8 Hours]
University Portion (80%): (7 Hours)
Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors (Bentley: Sections 8.1 to 8.6)

Module-3 [8 Hours]
University Portion (80%):(7 Hours)
Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation. IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement. (Ghosh: Section 10.3 to 10.4)
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Module-4 [9 Hours]
University Portion (80%): (8 Hours)
Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity. Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation (Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)

Text Books:

1. *Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.*
2. *Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.*

Reference Books:

1. *Measurement Systems Application and Design- E.O. Doeblin (4/e), McGraw-Hill, International, NY.*
2. *Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.*
3. *Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.*

Fifth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Power Electronics	3-0	3	100	50	2	1	50
PC	Microprocessor & Microcontroller	3-0	3	100	50	2	1	50
PC	Digital signal Processing	3-0	3	100	50	2	1	50
PE	Renewable Energy systems/Optoelectronics Device & Instrumentation	3-1	4	100	50			
OE	Optimization in Engg.	3-1	4	100	50			
PC	Advance Lab-I(Advanced Electrical Computational Lab-I)					8	4	200
Total		17	17	500	250	14	7	350
Total Marks: 1100								
Total Credits: 24								
Honors	Electrical Machine Design/ Industrial Process Control and Dynamics /Distributed Generation System Design	4	4	100	50			
Minor	Electrical Machines-I/ Microprocessor and Microcontrollers/ Renewable Energy Systems							

Semester : 5th

1.	PEE5D001	Honours(O4)	Electrical Machine Design	4-0-0	4
2.	PEE5D002	Honours(O4)	Industrial Process Control & Dynamics	4-0-0	4
3.	PEE5D003	Honours(O4)	Distributed Generation System Design	4-0-0	4
4.	PEE5G001	Minor(O5)	Electrical Machines - I	4-0-0	4
5.	PEE5G002	Minor(O5)	Microprocessor & Microcontroller	4-0-0	4
6.	PEE5G003	Minor(O5)	Renewable Energy Systems	4-0-0	4
7.	PEE5H001	OE(CP)	Optimization in Engineering	4-0-0	4
8.	PEE5I101	PC(CP)	Power Electronics	3-0-1	4
9.	PEE5I102	PC(CP)	Microprocessor & Microcontroller	3-0-1	4
10.	PEE5I103	PC(CP)	Digital signal Processing	3-0-1	4
11.	PEE5I201	PC(CP)	Advance Lab - I (Advanced Electrical Computational Lab-I)	0-0-4	4
12.	PEE5J001	PE(O3)	Renewable Energy Systems	4-0-0	4
13.	PEE5J002	PE(O3)	Optoelectronics Device & Instrumentation	4-0-0	4
					28

PEE5I101 POWER ELECTRONICS

Module-1 **[12 Hours]**

University portion (80%): (10 Hours)

Power semiconductor devices: (6 Hours)

Switching and V-I characteristic of devices: power diode, Thyristor family: SCR, TRIAC, GTO, Transistor Family: BJT, IGBT, and MOSFET, Series and parallel grouping of SCR. [Chapter: 1.3, 1.4, 4.2.2, 4.2.3, 4.3.2, 4.6, 4.10, 7.2, 7.4, 7.5]

Triggering Methods: (2 Hours)

SCR: (Cosine Firing Scheme), BJT gate drive, IGBT gate drive, TRIAC firing circuit, Isolation of gate and base drive [Chapter: 17.5, 17.2, 17.3, 17.4]

Protection of Devices: (2 Hours)

SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection. Transistor: protection of power BJT, IGBT and power MOSFET, dv/dt & di/dt limitation. [Chapter: 18.4, 18.5, 18.7, 18.8, 4.8, 7.9, 7.10)

Module 2 **[12 Hours]**

University portion (80%): (10 Hours)

AC to DC converter: (6 Hours)

Un-controlled Diode rectifier: Single phase half wave and full wave rectifiers with R-L and R -L-E load, 3 phase bridge rectifier with R-L and R-L-E load. Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R-L and R-L-E load,3 phase full converter with R-L and R-L-E load ,single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load and effect of source inductance. [Chapter: 3.2, 3.3, 3.4, 3.5, 3.8, 3.12, 10.2, 10.3, 10.6, 10.9, 10.10]

AC –AC converter: (4 Hours)

AC voltage controller: Single phase bi-directional controllers with R and R-L load, single phase cycloconverters. [Chapter: 11.4, 11.5, 11.9.1, 11.10]

Module 3 **[8 Hours]**

University portion (80%): (6 Hours)

DC to DC converter:

Classification: First quadrant, second quardrant, first and second quardrant, third and fourth quardrant, fourth quardrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Cuk regulators, Isolated Types: Fly Back Converters, Forward converters, Push Pull Converters, Bridge Converter [Chapter: 5.7, 5.8.1, 5.8.2, 5.8.3, 5.8.4]

Module 4 **[8 Hours]**

University portion (80%): (6 Hours)

DC to AC converter: (4 Hours)

Inverters: Single phase Bridge Inverters, 3-Phase Inverters-1800 mode conduction, 1200 mode conduction. Voltage control of 3-Phase Inverters by Sinusoidal PWM, Current Source Inverter [Chapter: 6.4, 6.5, 6.8.1, 6.8.4, 6.10, 8.8, 8.9]

Applications: (2 Hours)

UPS, SMPS, Battery Chargers, SVC. [Chapter: 14.2.1, 14.2.2, 14.2.3, 14.2.4, 14.2.6, 13.6.4]

Text Books:

1. *Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, Pearson*
2. *Power Electronics: By P. C. Sen, Tata McGraw Hill Education, 12th Edition*
3. *Power Electronics, V R Moorthi, Oxford University Press*

Reference Books:

1. *Power Electronics Converters, Applications & Design: by N. Mohan, 2nd Edition, John Wiley & Sons*
2. *Elements Of Power Electronics: Philip T. Krein, Oxford University Press*
3. *Power Converter Circuits: by W Shepherd and L Zhang, CRC, Taylor and Francis,Special Indian Edition*

POWER ELECTRONICS LABORATORY

List of Experiment : (any ten)

1. *Study of the V-I characteristics of SCR, TRIAC, IGBT and MOSFET.*
2. *Study of the cosine controlled triggering circuit*
3. *To measure the latching and holding current of a SCR*
4. *Study of the single phase half wave controlled rectifier and semi converter circuit with R and R-L Load*
5. *Study of single phase full wave controlled rectifier circuits (mid point and Bridge type) with R and R-L Load*
6. *Study of three phase full wave controlled rectifier circuits (Full and Semi converter) with R and R-L Load*
7. *Study of the Buck converter and boost converter.*
8. *Study of the single phase pwm voltage source inverter.*
9. *Study the performance of three phase VSI with PWM control.*
10. *Study of the forward converter and flyback converter.*

PEE5I102 MICROPROCESSORS AND MICROCONTROLLER

Module-I **[10 Hours]**

University Portion (80%):(08 Hours)

Introduction of Microcomputer System: Fundamental block diagram, signal, interfacing, I/O ports and data transfer concepts, timing diagram, interrupt structure of Intel 8085 processor. Introduction of Intel 8086 processor. Basic difference between 8085 and 8086 processor. Timer and Counter. (Book 1: 2.2, 2.3, 2.4, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 13.1)

Module-II **[10 Hours]**

University Portion (80%): (08 hours)

Instructions and programming of 8085 and 8086: Instruction format and addressing modes, assembly language format, data transfer, data manipulation, Arithmetic instructions, Logical instructions, control and string instruction, programming: loop structure with counting and indexing, look up table, sub routine instruction stack. Stack operation, branching programming.(Book 2: Ch. 5 and 6)

Module-III **[10 Hours]**

University Portion (80%):(08 Hours)

I/O Interfacing devices

Study of Architecture and programming of ICs : 8-bit input output port 8255 PPI, 8259 PIC, 8257 DMA, 8251 USART, 8279 Keyboard display controller and 8253 timer/counter-interfacing with 8085- A/D and D/A converter interfacing(Book 1: Ch. 7)

Module-IV **[10 Hours]**

University Portion (80%): (08 Hours)

Micro controller 8051 programming and applications. Architecture of 8051. Data Transfer, manipulation, control and I/O instruction, simple programming, keyboard and display interface.(Book 1: Ch. 9 and 10)

Text book:

1. *Ramesh S.Gaonkar, "Microprocessor - Architecture, Programming and Applications with the 8085", Penram International publishing private limited, fifth edition.*
2. *Douglas V. Hall, "Microprocessors and Interfacing: Programming and Hardware",*
3. *Microprocessor & Microcontroller, N.Senthil Kumar, M.Saravanan,S. Jeevananthan, Oxford University Press*

Reference Book:

1. *Muhammad Ali Mazdi & Janice Gilli Mazdi, The 8051 Microcontroller and Embedded System, Pearson Education , 5th Indian reprint, 2003.*
2. *Microprocessors and microcontrollers Architecture, programming and system Design 8085, 8086, 8051, 8096: by Krishna Kant : PHI*
3. *The 8051 Microcontroller, Kenneth Ayala, Third Edition*

MICROPROCESSOR & MICROCONTROLLER LABORATORY

List of Experiment : 8085

1. *Addition, subtraction, multiplication and division of two 8 bit numbers*
2. *Smallest/largest number among n numbers in a given data array, Binary to Gray code, Hexadecimal to decimal conversion*

Interfacing

1. *Generate square wave on all lines of 8255 with different frequencies*
2. *Study of stepper motor and its operations*

Optional (any two)

1. *Study of traffic light controller*
2. *Study of elevator simulator*
3. *Generation of square, triangular and saw tooth wave using D to A Converter*
4. *Study of 8253 and its operation(Mode0, Mode2, Mode3)*
5. *Study of Mode0,Mode1 and BSR Mode operation of 8255*
6. *Study of 8279 (keyboard and display interface)*
7. *Study of 8259 Programmable Interrupt Controller*
8. *8051 Microcontroller: Initialize data to registers and memory using immediate, register, direct and indirect Addressing mode*

Optional (any one)

1. *Addition and subtraction of 16 bit numbers*
2. *Multiplication and division of two 16 bit numbers*
3. *Transfer a block of data to another memory location using indexing*
4. *Operation of 8255 using 8051 microcontroller 8086*
5. *1.Addition , subtraction ,multiplication and division of 16 bit numbers, 2's complement of a 16 bit number*

Optional (any one)

1. *Finding a particular data element in a given data array*
2. *Marking a specific bit of a number using look-up table*
3. *Largest/smallest number of a given data array*
4. *To separate the odd and even numbers from a given data array*
5. *Sorting an array of numbers in ascending/descending order*

PEE5I103 DIGITAL SIGNAL PROCESSING

MODULE – I

1. **The Z-Transform and Its Application to the Analysis of LTI Systems:**

   The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; Analysis of Linear Time-Invariant Systems in the z-Domain: Response of Systems with rational System Functions.

2. **The Discrete Fourier Transform: Its Properties and Applications:**
   Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

MODULE – II

3. **Implementation of Discrete-Time Systems:**
   Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

4. **Design of Digital Filters:**
   General Considerations: Causality and Its Implications, Characteristics of Practical Frequency-Selective Filters; Design of FIR Filters: Symmetric and Antisymmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

MODULE- III

5. **Efficient Computation of the DFT: Fast Fourier Transform Algorithm**
   Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT,Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence.

MODULE – IV

6. **Adaptive Filters:**
   Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive

Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Additional Module (Terminal Examination-Internal)

1. **The Z-Transform and Its Application to the Analysis of LTI Systems:**Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.
2. **The Discrete Fourier Transform: Its Properties and Applications:**Filtering of Long Data Sequences; Frequency Analysis of Signals using the DFT.
3. **Efficient Computation of the DFT:** Use of the FFT Algorithm in Linear Filtering and Correlation.

Text Books

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press.

Reference Books

1. Digital Signal Processing: a Computer-Based Approach, Sanjit K. Mitra, TMH
2. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.
3. Digital Signal Processing, Manson H. Hayes, Schaum's Outlines, TMH.
4. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
5. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
6. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
7. Digital Signal Processing: A MATLAB-Based Approach, Vinay K. Ingle and John G. Proakis, Cengage Learning.
8. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling and Sandra L. Harris, Cengage Learning.

DIGITAL SIGNAL PROCESSING LAB

(At least 10 experiments should be done)

1. Familiarization with the architecture of a standard DSP kit (Preferably TMS 320C6XXX DSP kit of Texas Instruments)
2. Generation of various types of waveforms (sine, cosine, square, triangular etc.) using MATLAB and DSP kit.
3. Linear convolution of sequences (without using the inbuilt conv. function in MATLAB) and verification of linear convolution using DSP kit.
4. Circular convolution of two sequences and comparison of the result with the result obtained from linear convolution using MATLAB and DSP kit.
5. (i) Computation of autocorrelation of a sequence, cross correlation of two sequences using MATLAB.

   (ii) Computation of the power spectral density of a sequence using MATLAB also implementing the same in a DSP kit.
6. Finding the convolution of a periodic sequence using DFT and IDFT in MATLAB.
7. (i) Implementation of FFT algorithm by decimation in time and decimation in frequency using MATLAB.

   (ii) Finding the FFT of a given 1-D signal using DSP kit and plotting the same.
8. Design and implementation of FIR (lowpass and highpass) Filters using windowing techniques (rectangular window, triangular window and Kaiser window) in MATLAB and DSP kit.
9. Design and implementation of IIR (lowpass and highpass) Filters (Butterworth and Chebyshev) in MATLAB and DSP kit.
10. (i) Convolution of long duration sequences using overlap add, overlap save using MATLAB.

    (ii) Implementation of noise cancellation using adaptive filters on a DSP kit.

PEE5J001 RENEWABLE ENERGY SYSTEMS

Module I **[15 Hours]**

University Portion (80%): (13 Hours)

Introduction: Conventional energy Sources and its Impacts, Non conventional energy– seasonal variations and availability, Renewable energy – sources and features, Distributed energy systems and dispersed generation (DG) (Textbook-1, Chapter-1.10, 1.13, 1.14)

Solar Energy: Solar processes and spectral composition of solar radiation. Solar Thermal system-Solar collectors, Types and performance characteristics, Applications-Solar water heating systems (active & passive) , Solar space heating & cooling systems , Solar desalination systems, Solar cooker. Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Losses in Solar Cell, Effects of Shadowing-Partial and Complete Shadowing, Series and parallel connections, Cell mismatching, Maximum power point tracking, Applications-Battery charging, Pumping, Lighting, Peltier cooling. Modeling of PV cell. (Textbook-1, Chapter- 4.1, 4.2, 4.5, 4.10, 4.11, 5, 6)

Module II **[10 Hours]**

University Portion (80%): (8 Hours)

Wind Energy: Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation, Characteristics of wind power plant, Concept of DFIG. (Textbook-2, Chapter-1.2, 1.4, 1.5, 1.6, 1.7, 1.8, 1.10, 1.11, 1.12, 3, 5)

Module III[9 Hours]

University Portion (80%):(9 Hours)

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gassifier, Pyrolysis, Applications. Bio gas, Wood stoves, Bio diesel, Combustion engine, Application.
(Textbook-1, Chapter-8)

Module IV **[6 Hours]**

University Portion (80%): (4 Hours)

Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles.
(Textbook-2, Chapter-7)

Text Books:

1. *Renewable Energy- Power for a Sustainable Future, Godfrey Boyle, Oxford University Press*
2. *B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009*
3. *S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press, New Delhi, 2005.*

Reference Books:

1. *S. A. Abbasi, N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, New Delhi, 2006*

PEE5J002 OPTOELECTRONICS DEVICE & INSTRUMENTATION

Institution Level(80%)

Module –1 (14 Hrs)

Wave Optics: Wave Polarization, Transmission of light through slab, Numerical aperture, Wave propagation in cylindrical waveguides, Modes in step and graded index fibers, single mode and multimode fibres

Module –2 (10 Hrs)

Optical Components: Sources: LED, Lasers-fundamentals, conditions for oscillations, construction and principle of operation of semiconductor lasers, pulsed and continuous type lasers (Chapter 4 of TB-1, 11.2-11.4 of TB-1, Chapter 4, 4.2-4.9 of TB-2)
Fiber optic components: (at college level) couplers, splicer, polarizer, power coupled to a fibre (Chapter 9 9.2-9.12 of TB-2) Detectors: photodiodes- PIN and APD. (Chapter 12, 12.1-12.4 of TB-1)

Module –3 (12 Hrs)

Optoelectronic Instrumentation:
Modulation techniques: intensity, polarization, interference, electro-optic, electromagnetic; Sensing techniques for displacement, pressure, acceleration, flow, current and voltage measurement, Fiber optic gyroscope, Distributed fiber optic sensors- OTDR and OFDR principles. (Chapter 11, 11.2-11.3.5, 11.3.9, 11.4-11.6 and 11.9 of TB-2)

Text Books:

1. *.A. Ghatak and K. Tyagrajan: Introduction to Fiber Optics: Cambridge University Press, New Delhi, 2004. (Chapter 2, Sections 7.2-7.3, Chapter 3, Sections 4.3,8.2, 17.2, 17.8, Section 11.3, 11.6, Chapter 12, Chapter 18)*
2. *A. Tripathy, Opto-Electronics and Systems: Studium Press, New Delhi, 2016*

Reference Books:

1. *R.P.Khare: Fibre Optics & Optoelectronics, Oxford University Press, New Delhi, 2010.*
2. *John M. Senior, Optical Fibre Communications, Principles and Practice, 3rd Edn, Pearson, 2010*
3. *J.P. Bentley- Principles of Measurement Systems (3/e), Pearson Education, New Delhi, 2007.*
4. *J. Wilson and J.F.B. Hawkes: Optoelectronics: An Introduction (2/e), PHI, New Delhi, 2001. (Chapter 1, Sections 3.1-3.2; 8.1-8.2, Sections 8.3-8.4, 8.5, Sections 4.6, 5.1-5.6, 5.10.2, 7.2, Sections 3.4, 3.7, 3.8, Chapter 10)*

PEE5H001 OPTIMIZATION IN ENGINEERING

MODULE-I

1. Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling.
2. **Linear programming:** Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

MODULE-II

3. **Transportation problems:** Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method
4. **Assignment problems:** Hungarian method for solution of Assignment problemsInteger Programming:Branch and Bound algorithm for solution of integer Programming Problems

MODULE-III

5. **Non-linear programming:** Introduction to non-linear programming. **Unconstraint optimization:** Fibonacci and Golden Section Search method.
6. **Constrained optimization with equality constraint:** Lagrange multiplier, Projected gradient method
7. **Constrained optimization with inequality constraint:** Kuhn-Tucker condition, Quadratic programming.

MODULE-IV

8. **Queuing models:** General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Additional Module (Terminal Examination-Internal)

9. Introduction to Genetic Algorithm.

Text Books

1. Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg, Second edition, Wiley India Pvt Ltd.
2. Operation Research, Prabhakar Pai ,Oxford University Press
3. Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.
4. OperationsResearch, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, Pearson Education, Eighth Edition.
5. Engineering Optimization, S S Rao, New Age International(P) Ltd, 2003.

Reference Books

1. Linear and Non-linear Optimization, **S**tephen G. Nash, A. Sofer, McGraw Hill,2nd Edition.
2. Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.
3. Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition, 2005.
4. Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.

PEE5I201 ADVANCE ELECTRICAL COMPUTATION LAB-I

List of Experiment:

1. Power measurement of AC system using MATLAB:
2. Time response of a first/ second order system using Laplace Transform.
3. Numerical analysis:Non-linear equations and optimization ,Differential equations
4. Series & parallel resonance circuit simulation.
5. Simulation of Half wave diode bridge rectifier circuit.
6. Simulation of Full wave diode bridge rectifier circuit.
7. DC analysis for R-L, R-C and R-L-C circuits using MATLAB .
8. AC analysis for R-L, R-C and R-L-C circuits using MATLAB .

PEE5D002 INDUSTRIAL PROCESS CONTROL AND DYNAMICS (3-0-0)

Module-1 **(10 Hours)**

University portion (80%): (8 Hours)

1. Introduction to Process Control:

Introduction, control systems, process control block diagram, control system evaluation, analog and digital processing

[Chapter : 1.1, 1.2, 1.3, 1.4, 1.5]

2. Analog Signal Conditioning:

Introduction, principles of analog signal conditioning, passive circuits, operation, amplifiers, op-amp circuits in instrumentation

[Chapter : 2.1, 2.2, 2.3, 2.4, 2.5]

College/Institute portion (20%): (2 Hours)

Units, Standards and Definitions, Sensors time response, Significance and Statistics **[Chapter: 1.6, 1.7, 1.8]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 2 **(10 Hours)**

University portion (80%): (8 Hours)

1. Digital Signal Conditioning:

Introduction, Review of digital fundamentals, converters, Data Acquisition system

[**Chapter: 3.1, 3.2, 3.3, 3.4]**

2. Thermal Sensors:

Introduction, Definition of temperature, Metal resistance versus Temperature devices, Thermistors, Thermocouples

[**Chapter: 4.1, 4.2, 4.3, 4.4, 4.5]**

3. Mechanical Sensors:

Introduction, Displacement, Location or Position sensors, Strain sensors, Motion sensors

[**Chapter: 5.1, 5.2, 5.3, 5.4]**

College/Institute portion (20%): (2 Hours)

Other thermal sensors, Pressure sensors, Flow sensors**[Chapter: 4.6, 5.5, 5.6]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 3 **(10 Hours)**

University portion (80%): (8 Hours)

1. Optical Sensors:

Introduction, Photo detectors, Pyrometry, Optical Sources application

[Chapter: 6.1, 6.3, 6.4, 6.5]

2. Final Control:

Introduction, Final control operation, signal conversions, Industrial Electronics, Actuators, Control Elements

[Chapter: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6]

3. Discrete State Process Control:

Introduction, Definition of Discrete State Process control, Characteristics of the system, Relay controllers and ladder diagram, PLCs

[Chapter: 8.1, 8.2, 8.3, 8.4, 8.5]

College/Institute portion (20%): (2 Hours)

Control Loop Characteristics **[Chapter: 12.1 – 12.6] o**r related advanced topics as decided by the concerned faculty teaching the subject.

Module 4 **(10 Hours)**

University portion (80%): (8 Hours)

1. Controller Principles:

Introduction, Process characteristics, Control system parameters, Discontinuous controller modes, continuous controller modes, composite control modes

[Chapter: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6]

2. Analog Controllers:

Electronics Controller, Pneumatic controller

[Chapter: 10.3, 10.4]

3. Digital Controllers:

Digital electronics methods, Computers in process control, Characteristics of digital data

[Chapter: 11.2, 11.3, 11.4]

College/Institute portion (20%): (2 Hours)

Controller Software, Computer Controller Examples **[Chapter: 11.5, 11.6]** or related advanced topics as decided by the concerned faculty teaching the subject.

Text Books:

4. ***Process Control Instrumentation Technology*** by Curtis D. Johnson, PHI Publication

PEE5D001 ELECTRICAL MACHINE DESIGN (3-1-0)

Module-I **(12 hours)**

University Portion (80%)

Design of Transformers: Classification of transformer, transformer core, yoke, transformer winding, cooling of transformers, method of cooling of transformers, transformer tank, cooling ducts, transformer insulation, conservator and breather, output of transformer, output equation, ratio of iron loss to copper loss, relation between core area and weight of iron and copper, optimum design, variation of output and lossless in transformers with linear dimensions, design of core, selection of core area and type of core, choice of flux density, design of windings, Design of insulation, surge phenomenon, surge protection widow space factor, window dimension, width of window for optimum output, design of yoke, overall dimensions, simplified steps for transformer design, operating characteristics, resistance of winding, leakage reactance of winding, regulation.

Ch- 5.2, 5.7, 5.10, 5.17, 5.18, 5.19, 5.20, 5.21, 5.24, 5.29, 5.30-5.45, 5.46, 5.47, 5.48

College/Institute Portion (20%)

Calculation of mechanical forces, bracing of windings, change of parameters with change of frequency, temperature rise of transformers, design of tanks with tubes, thermal rating.

Ch- 5.50, 5.51, 5.53,5.54, 5.55, 5.58

Module-II **(12 hours)**

University Portion (80%)

D C Machines; Output equations, choice of average gap density, choice of ampere conductor per meter, selection of number of poles, core length, Armature diameter, pole proportions, number of ventilating ducts, estimation of air gap length, **Armature reaction;** flux distribution at load, effect of armature reaction, brush shift and its effect, reduction of effects of armature reaction **Armature design;** choice of armature winding, numbers of armature conductors, numbers of armature slots, cross section of armature conductors, insulation of armature winding, slot dimension, armature voltage drop, depth of armature core, **Design of field system;** pole design, design of field winding, design of yoke, magnetic circuit, magnetization curve, design of field winding, commutation phenomenon, forms of current in coil undergoing commutation, **Design of commutator and brushes;** number of segments, commutator diameter, length of commutator, dimension of brushes, losses at commutator surface, loss and efficiency.

Ch-9.10, 9.11-9.20, 9.22-9.30, 9.31-9.39

College/Institute Portion (20%)

Design of interpoles; time of commutation, width of commutation zone, width of interpole shoe, calculation of reactance voltage, length of interpole, flux density under interpole shoe, design of interpole winding.

Ch-9.40-9.54

Module-III **(8 hours)**

University Portion (80%)

Three Phase Induction Motors; output equation, choice of average flux density in air gap, choice of armature conductors, efficiency and power factor, main dimensions, stator winding, Shape of stator slots, number of stator slots, area of stator slots, length of mean turn, stator teeth, stator core, **Rotor design;** length of air gap, number of rotor slots, effects of harmonics, reduction of harmonic torques, design of rotor bars and slots, design of end rings, full load slip, design of wound rotor, rotor teeth, rotor core, operating characteristics; no load current, short circuit current, leakage reactance.

Ch-10.9, 10.10, 10.11-10.22, 10.22.2, 10.23-10.25, 10, 27, 10.31

College/Institute Portion (20%)

Circle diagram, dispersion coefficient and its effects, effects of change of air gap length, effect of change of number of poles, effect of change of frequency, relation between D and L for best power factor, method of improving starting torque, loss and efficiency.

Ch -10.32,10.34, 10.35-10.38

Module-IV **(12 hours)**

University Portion (80%)

Design of synchronous Machines; output equation, design of salient pole machines-main dimensions, short circuit ratio, length of air gap, shape of pole face, armature design, armature winding, coils and their insulation, slot dimension, length of mean turn, stator pole, elimination of harmonics, armature parameters, estimation of air gap length, design of rotor, magnetic circuits, Open circuit characteristics, determination of full load field mmf, design of field winding, design of turbo-Alternator- main dimension, length of air gap, stator design, rotor design.

Ch-11.8 - 11.25 and 11. 30 – 11.33

College/Institute Portion (20%)

Determination of direct and quadrature axis synchronous reactances, short circuit characteristics, losses, temperature rise,

Ch- 11.26 -11.29.

Text book

1. A course in Electrical Machine Design by A.K. Sawhney and Dr. A. Chakrabarti – Publisher: Dhanpat Rai & Company Pvt. Ltd., Year of Edition- 2015

References

2. Clayton A E & Hancock N N : The Performance and Design of Direct Current Machines ; CBS Publishers and Distributors Electrical Engineering
3. Say M G : The Performance and Design of Alternating Current Machines; CBS Publishers and Distributors
4. Sen S K : Principles of Electrical Machine Design with Computer Programs ; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi,
5. A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age Intenational Pvt. Ltd.

Sixth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Electrical Drives	3-0	3	100	50	2	1	50
PC	Power System & Operation & Control	3-0	3	100	50	2	1	50
PE	VLSI Design/Generalized Theory of Electrical Machines/HVDC Transmission	3-1	4	100	50			
PE	Control System Engineering II/Advanced Digital Signal Processing	3-1	4	100	50			
MC & GS	Environmental Science & Engineering	3-0	3	100	50			
OE	Industrial Lecture #					3	1	50
HS	Business Communication & Skill for Interview ##	2-0	1		50	4	2	100
MC	Yoga					2	1	50
Total		19	18	500	300	13	6	300
Total Marks: 1100								
Total Credits: 24								
Honors	Special Electromechanical Devices / Flexible AC Transmission Systems /Utilization of Electrical Energy	4	4	100	50			
Minor	Electrical Machines-II/ Control System Engineering-II							

Semester : 6th

Sl. No.	Subject Code	Category	Subject Name	L-T-P	Credit
1.	PEE6D001	Honours(O3)	Special Electro-Mechanical in Devices	4-0-0	4
2.	PEE6D002	Honours(O3)	Flexible AC Transmission Systems	4-0-0	4
3.	PEE6D003	Honours(O3)	Utilization of Electrical Energy	4-0-0	4
4.	PEE6E101	HS(CP)	Business Communication & Skill for Interview	1-0-2	3
5.	PEE6G001	Minor(O4)	Electrical Machines - II	4-0-0	4
6.	PEE6G002	Minor(O4)	Control System - II	4-0-0	4
7.	PEE6H301	OE(CP)	Industrial Lecture #	0-0-1	1
8.	PEE6I101	PC(CP)	Electrical Drives	3-0-1	4
9.	PEE6I102	PC(CP)	Power System & Operation & Control	3-0-1	4
10.	PEE6J001	PE(O1)	VLSI Design	4-0-0	4
11.	PEE6J002	PE(O1)	Generalized Theory of Electrical Machines	4-0-0	4
12.	PEE6J003	PE(O1)	HVDC Transmission	4-0-0	4
13.	PEE6J004	PE(O2)	Control System Engineering - II	4-0-0	4
14.	PEE6J005	PE(O2)	Advanced Digital Signal Processing	4-0-0	4

PEE6I101 ELECTRIC DRIVES (3-0-1)

MODULE-I **(10 HOURS)**

University portion (80%): (8 Hours)

Requirements, AC and DC drives, Advantages of Electrical Drives, Fundamentals of Torque Equations, Speed Torque Conventions and Multi-quadrant Operation, Equivalent Values of Drive Parameters, Components of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization, Control of Electrical Drives, Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **[Book 1 Ch- 1.1,1.2,2,3,4]**

College/Institute portion (20%): (2 Hours)

Electrical Motors, Power Modulators, Choice of electrical Drives, modern trends in drives technology, Nature and Classification of Load Torques. **[Book 1 Ch- 1.3,1.4,1.5,2.5]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-II **(10 HOURS)**

University portion (80%): (8 Hours)

Steady State Performance of DC/AC Drives:DC Motors and their Performances, Starting, Braking, Transient Analysis, Speed Control, Methods of Armature Voltage Control, Controlled Rectifier Fed DC Drives,Induction Motor Drives: Speed Control, Pole Changing, Pole Amplitude Modulation, Stator Voltage Control, Variable Frequency Control from Voltage Source, Voltage Source Inverter Control, Variable Frequency Control from Current Source, Current Source Inverter Control, Current Regulated Voltage Source Inverter Control, Rotor Resistance Control, Slip Power Recovery.**[Book 1 Ch- 5.1,5.2,5.3,5.4,5.5,5.6,5.9,6.8, 6.9,6.10,6.11,6.12,6.13,6.16,6.17,6.18,6.20,6.21]**

College/Institute portion (20%): (2 Hours)

Transformer and Uncontrolled Rectifier Control, Chopper Controlled DC Drives.**[Book 1 Ch- 5.8,5.18]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-III **(10 HOURS)**

University portion (80%): (8 Hours)

Synchronous Motor Drives: Synchronous Motor Variable Speed Drives, Variable Frequency Control of Multiple Synchronous Motors. Electric Traction: System of electric traction Mechanics of Train Movement: Speed- time, distance- time and simplified speed-time curves, Attractive effort for acceleration and propulsion, effective weight, train resistance, adhesive weight, specific energy output and consumption. **[Book 1 Ch- 7.3, 7.4,10.2,10.6]**

College/Institute portion (20%): (2 Hours)

Traction Motors: Review of characteristics of different types of DC and AC motors used in traction and their suitability.**[Book 1 Ch- 10.10.9,10.10,10.12,10.15,10.16]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-IV **(10 HOURS)**

University portion (80%): (8 Hours)

Drives for specific application like Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives, Cement Mills, Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps. Application Areas and Functions of Microprocessors in Drive Technology.**[Book 2 Ch-7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.3]**

College/Institute portion (20%): (2 Hours)

Control of DC Drives using Microprocessors, some aspects of control system design of microprocessor based variable speed drive **[Book 2 Ch-8.4,8.5]** Or related advanced topics as decided by the concerned faculty teaching the subject.

BOOKS

[1]. G.K.Dubey,Norasa Pub. House ND "Electric Drive"
[2]. V.Subrahmanyam,TMH "Electric Drives"
[3]. M.H.Rashid (P.H.I.Edition)"Power Electronics"

Electrical Drives Lab

(Any Eight Experiments)

1. Speed Control of Single Phase Induction Motor by using Single Phase AC to AC Converter.
2. Speed Control of Separately Excited DC Shunt Motor using Single Phase Fully Controlled AC to DC Converter.
3. Speed Control of Separately Excited DC Shunt Motor using Four-Quadrant Chopper.
4. Speed Control of Separately Excited DC Shunt Motor using Single Phase Dual Converter.
5. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase AC to AC Controller.
6. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase PWM Inverter.
7. Speed Control of Three Phase Slip Ring Induction Motor using Rheostatic Control Method.
8. Speed Control of DC Shunt Motor using Three Phase AC to DC Converter.
9. Determination of the Transfer Function of DC Shunt Motor.
10. Determination of the Moment of Inertia of DC Shunt Motor Drive System by Retardation Test.

PEE6I102 POWER SYSTEM OPERATION & CONTROL (3-0-1)

Module – I **[14 Hours]**

University Portion (80%): (12 Hours)

Fundamentals of Power System (Book No.1, Ch. 1)

Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, Per-Unit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, The Single Line or One Line Diagram, Impedance and Reactance Diagrams. (Book-1:Ch. 1.1, Ch. 1.2, Ch. 1.3, Ch. 1.4, Ch. 1.5, Ch. 1.6, Ch. 1.7, Ch. 1.8, Ch. 1.9, Ch. 1.10, Ch. 1.11, Ch. 1.12, Ch. 1.13, Ch. 1.14).

The Admittance Models & Network Calculations (Book – 1: Ch. 7 (7.1 To 7.5))

Branch and Node Admittances, Mutually Coupled Branches in Ybus, an Equivalent Admittance Network, Modification of Ybus, the Network Incidence Matrix and Ybus. (Book-1:Ch. 7.1, Ch. 7.2, Ch. 7.3, Ch. 7.4, Ch. 7.5.)

Power Flow Solutions (Book – 1, Ch. 9)

The Power-Flow Problem, the Gauss-Seidal Method, the Newton-Raphson Method, the Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, the Decoupled Method. (Book-1:Ch. 9.1, Ch. 9.2, Ch. 9.3, Ch. 9.4, Ch. 9.5, Ch. 9.6, Ch. 9.7.)

Module – II **[14 Hours]**

University Portion (80%): (12 Hours)

Economic Operation of Power System (Book – 1, Ch.13)

Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.

(Book-1: Ch. 13.1, Ch. 13.2, Ch. 13.3, Ch. 13.4, Ch. 13.5, Ch. 13.6, Ch. 13.7, Ch. 13.8.)

Load Frequency Control, Control Area Concept (Book – 2, Ch.9)

Automatic Load-Frequency Control of Single Area Systems: Speed-Governing System, Hydraulic Valve Actuator, Turbine-Generator Response, Static Performance of Speed Governor, Closing the ALFC Loop, Concept of Control Area, Static Response of Primary ALFC Loop, Dynamic Response of ALFC Loop, Physical Interpretation of Results, The Secondary ("Reset") ALFC Loop, Economic Dispatch Control. (Book – 2: Ch. 9.3.1, Ch. 9.3.2, Ch. 9.3.3,Ch. 9.3.1, Ch. 9.3.4, Ch. 9.3.5, Ch. 9.3.6, Ch. 9.3.7, Ch. 9.3.8, Ch. 9.3.9, Ch. 9.3.10, Ch. 9.3.11.)

Module – III **[6 Hours]**

University Portion (80%) : (4 Hours)

Two Area Systems (Book – 2, Ch.9)

ALFC of Multi-Control-Area Systems (Pool Operation): The Two Area Systems, Modeling the Tie-Line, Block Diagram Representation of Two Area System, Mechanical Analog of Two Area System, Dynamic Response of Two Area System, Static System Response, Tie-Line Bias Control of Multi-area Systems. (Book – 2: Ch. 9.4.1, Ch. 9.4.2, Ch. 9.4.3 Ch. 9.4.1, Ch. 9.4.4, Ch. 9.4.5, Ch. 9.4.6, Ch. 9.4.7, Ch. 9.4.8, Ch. 9.4.9, Ch. 9.4.10.)

Module- IV **[6 Hours]**

University Portion (80%) : (4 Hours)

Power System Stability (Book-1, Ch.16)

The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal-Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability. (Book-1:Ch. 16.1, Ch. 16.2, Ch. 16.3, Ch. 16.4, Ch. 16.5, Ch. 16.6, Ch. 16.7, Ch. 16.8, Ch. 16.9, Ch. 16.10, Ch. 16.11.)

Text Books:

1. *Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, Fifteenth Reprint.*
2. *An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH, Second Edition.*
3. *Power System Analysis, T K Nagsarkar and M S Sukhija, Oxford University Press*

Reference:

1) *Power System Analysis- By Hadi Saadat, TMH, 2002 Edition, Eighth Reprint.*
2) *Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6th Reprint, 2010.*

POWER SYSTEM LAB

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

Group A: *HARDWARE BASED*

1. *To determine negative and zero sequence synchronous reactance of an alternator.*
2. *To determine sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.*
3. *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.*
4. *To study the IDMT over-current relay and with different plug setting and time setting multipliers and plot its time – current characteristics.*
5. *To determine the operating characteristics of biased different relay with different % of biasing.*
6. *To study the MHO and reactance type distance relays.*
7. *To determine A, B, C, D parameters of an artificial transmission line.*
8. *To compute series inductance and shunt capacitance per phase per km of a three phase line with flat horizontal spacing for single stranded and bundle conductor configuration.*
9. *To determine location of fault in a cable using cable fault locator.*
10. *To study the Ferranti Effect and voltage distribution in HV long transmission line using transmission line model.*
11. *Insulation test for Transformer oil.*
    a) *Study of various types of Lightning arrestors.*
    b) *Study of layout of outdoor pole mounted & plinth mounted sub-stations.*

Group B : *SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)*

1. *To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.*
2. *To formulate the Y-Bus matrix and perform load flow analysis.*
3. *To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use Π model.*
4. *To perform symmetrical fault analysis in a power system.*
5. *To perform unsymmetrical fault analysis in a power system.*
6. *Write a program in 'C' language to solve economic dispatch problem of a power system with only thermal units. Take production cost function as quadratic and neglect transmission loss.*

Text books:

1. *Hadi Sadat- Power System Analysis – TMH*
2. *T. K. Nagsarkar and M. S. Sukhija - Power System Analysis – Oxford University Press*

PEE6J001 VSLI DESIGN (4-0-0)

Module – I 08 Hours

Introduction: Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Computer-Aided Design Technology.

Fabrication of MOSFETs: Introduction, Fabrication Processes Flow – Basic Concepts, The CMOS n-Well Process, Layout Design Rules, Stick Diagrams, Full-Customs Mask Layout Design.

MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.

(Chapter 1 to 3 of Text Book 1 and for Stick Diagram Text Book 2)

Module – II 14 Hours

MOS Inverters – Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter.

MOS Inverters – Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Combinational MOS Logic Circuits: Introduction, MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates).

(Chapter 5 to 7 of Text Book 1)

Module – III 18 Hours

Sequential MOS Logic Circuits: Introduction, Behaviour of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Non-volatile Memory, Flash Memory.

Design for Testability: Introduction, Fault Types and Models, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques, Current Monitoring I_{DDQ} Test.

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, *CMOS Digital Integrated Circuits: Analysis and Design*, 3rd Edn., Tata McGraw-Hill Publishing Company Limited, 2003.
2. K. Eshraghian and N.H.E. Weste, *Principles of CMOS VLSI Design – a Systems Perspective*, 2nd Edn., Addison Wesley, 1993.

Reference Books:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits – A Design Perspective*, 2nd Edn., Pearson Education, 2003.
2. Debaprasad Das, *VLSI Design*, Oxford University Press, 2015
3. Wayne Wolf, *Modern VLSI Design System – on – Chip Design*, 3rd Edn., Pearson Education, 2003.
4. John P. Uyemura, *CMOS Logic Circuit Design*, Springer (Kluwer Academic Publishers), 2001.
5. Ken Martin, *Digital Integrated Circuit Design*, Oxford University Press, 2000.

PEE6J002 GENERALIZED THEORY OF ELECTRICAL MACHINES (3-1-0)

Module – 1: **[10 hours]**

University portion (80%):

Theory of electromechanical energy conversion: Magnetically Coupled Circuits, Electromechanical Energy Conversion, Elementary ac Machines. (Ch-1.1,1.2,1.3,1.4)

Distributed windings in ac machinery: Describing Distributed Windings, Winding Functions, Air-Gap Magneto motive Force, Rotating MMF, Flux Linkage and Inductance, Resistance, Voltage and Flux Linkage Equations for Distributed Winding Machines.(Ch-2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8)

Reference-frame theory: Equations of Transformation, Change of Variables, Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Commonly Used Reference Frames, Transformation of a Balanced Set, Balanced Steady-State Phasor Relationships, Balanced Steady-State Voltage Equations.
(Ch-3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8)

Institute portion (20%):

Variables Observed from Several Frames of Reference, Transformation between Reference Frames, Specialty Transformations, Space-Phasor Notation(Ch-3.9,3.10,3.11,3.12) Or Related topics as decided by the concerned faculty teaching the subject

Module – 2: **[10 hours]**

University portion: (80%)

Permanent-magnet AC machines: Voltage and Torque Equations in Machine Variables, Voltage and Torque Equations in Rotor, Reference-Frame Variables, Analysis of Steady-State Operation, Brushless dc Motor, Phase Shifting of Applied Voltages of a Permanent-Magnet ac Machine, Control of Stator Currents.
(Ch-4.1,4.2,4.3,4.4,4.5,4.6,4.7)

Synchronous Machines: Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Stator Voltage Equations in Arbitrary Reference-Frame Variables, Voltage Equations in Rotor Reference-Frame Variables, Torque Equations in Substitute Variables, Rotor Angle and Angle Between Rotors(Ch-5.1,5.2,5.3,5.4,5.5,5.6,5.7)

Institute portion (20%):

Per Unit System, Analysis of Steady-State Operation, Stator Currents Positive Out of Machine, Synchronous Generator Operation, Computer Simulation.(Ch-5.8,5.9,5.10,5.11) Or Related topics as decided by the concerned faculty teaching the subject

Module – 3: **[10 hours]**

University portion: (80%)

Symmetrical Induction Machines: Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Equations of Transformation for Rotor Circuits, Voltage Equations in Arbitrary Reference-Frame Variables, Torque Equation in Arbitrary Reference-Frame Variables, Commonly Used Reference Frames, Per Unit System, Analysis of Steady-State Operation, Free Acceleration Characteristics, Free Acceleration Characteristics Viewed from Various Reference Frames.(Ch-6.1,6.2,6.3,6.4,6.5,6.6,6.7,6.8,6.9,6.10,6.11)

Institute portion (20%):

Dynamic Performance During Sudden Changes in Load Torque , Dynamic Performance During a Three-Phase Fault at the Machine Terminals, Computer Simulation in the Arbitrary Reference Frame(Ch-6.12,6.13,6.14) Or Related topics as decided by the concerned faculty teaching the subject

Module – 4: **[10 hours]**

University portion: (80%)

Machine Equations in operational impedances and time constants: Park's Equations in Operational Form, Operational Impedances and G(p) for a Synchronous Machine with Four Rotor Windings, Standard Synchronous Machine Reactances, Standard Synchronous Machine Time Constants, Derived Synchronous Machine Time Constants, Parameters from Short-Circuit Characteristics, Parameters from Frequency-Response Characteristics(Ch-7.1,7.2,7.3,7.4,7.5,7.6,7.7,7.8)

Alternative forms of machine equations: Machine Equations to Be Linearized, Linearization of Machine Equations, Small-Displacement Stability: Eigen values, Eigen values of Typical Induction Machines, Eigen values of Typical Synchronous Machines, Neglecting Electric Transients of Stator Voltage Equations, Induction Machine Performance Predicted with Stator Electric Transients Neglected(Ch-8.1,8.2,8.3,8.4,8.5,8.6,8.7,8.8)

Institute portion (20%):

Synchronous Machine Performance Predicted with Stator Electric Transients Neglected, Detailed Voltage Behind Reactance Model, Reduced Order Voltage Behind Reactance Model (Ch-8.9,8.10,8.11) Or Related topics as decided by the concerned faculty teaching the subject

Text Book:

1. Analysis of Electric Machinery and Drive Systems, 3rd Edition, by Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek (Chapter 1- Chapter 8)

Reference:

1. Generalized Machine Theory by P.S Bimbhra

PEE6J003 HIGH VOLTAGE DC TRANSMISSION (4-0-0)

(Revised)

MODULE-I[12 hrs]

INTRODUCTION TO HVDC TRANSMISSION: Basic concepts of power transmission, Comparison of AC and DC Transmission, Application of DC transmission, description of dc transmission system, Planning of HVDC transmission. Morden trends in HVDC technology. Operating problems in HVDC transmission. HVDC transmission based on voltage converters.

MODULE-II[12 Hrs]

TYPES OF CONVERTERS: Line commutated converters and voltage source converters.Analysis of HVDC converters.

CONTROL OF HVDC CONVERTER AND SYSTEMS: Principle of DC link control, Converter control characteristics, firing angle control, current and extension angle control, starting and stopping of DC link, Synchronisation techniques for power converters.

MODULE-III[10 hrs]

CONVERTER FAULT & PROTECTION: Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines- Radio interference\

REACTIVE POWER AND HARMONICS CONTROL: Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters

MODULE-IV[8 hrs]

POWER FLOW ANALYSIS IN AC/DC SYSTEMS: Modelling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC loadflow – P.U. System for d.c. quantities-solution of AC-DC Power flow-Simultaneous method Sequential method.

Text Book:

1. HVDC Power Transmissions Systems: Technology & Systems Interaction, K.R.Padiyar, New Age Publication, 2005

Reference Book(s):

1. "**HVDC Transmission**" By S. Kamakshaiah& V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.
2. "HVDC and FACTS controllers" by Vijay K. Sood, KLUWER academic publishers.

PEE6J004 CONTROL SYSTEM ENGINEERING-II (4-0-0)

Module-I **[15 Hours]**

Discrete - Time Control Systems :

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process.

Digital Control Systems: Sample and Hold, Analog to digital conversion, Digital to analog conversion.The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorms of the Z-transform. The inverse Ztransform, Z Transform method for solving Difference Equations.

Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorm, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh stability critgion, Jury stability Test. Book No. 1: 1.1; 1.2; 1.4; 2.1; 2.2; 2.3; 2.4; 2.5; 2.6; 3.2; 3.4; 3.5; 4.2; 4.3.

Module -II **[15 Hours]**

State Variable Analysis & Design:

Introduction: Concepts of State, State Variables and State Model (of continuous time systems): State Model of Linear Systems, State Model for Single-Input-Single-Output Linear Systems, Linearization of the State Equation. State Models for Linear Continuous – Time Systems: State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors.

Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Effect of Pole-zero Cancellation in Transfer Function. Pole Placement by State Feedback, Observer Systems. State Variables and Linear Discrete – Time Systems: State Models from Linear Difference Equations/z-transfer Functions, Solution of State Equations (Discrete Case), An Efficient Method of Discretization and Solution, Linear Transformation of State Vector (Discrete-Time Case), Derivation of z-Transfer Function from Discrete-Time State Model. Book No. 2: 12.1 to 12.9.

Module -III **[12 Hours]**

Nonlinear Systems :

Introduction : Behaviour of Non linear Systems, Investigation of nonlinear systems. Common Physical Non Linearities: Saturation, Friction, Backlash, Relay, MultivariableNonlinearity. The Phase Plane Method: Basic Concepts, Singular Points: Nodal Point, Saddle Point, Focus Point, Centre or Vortex Point, Stability of Non Linear Systems: Limit Cycles, Construction of Phase Trajectories: Construction by Analytical Method, Construction by Graphical Methods. The Describing Function Method: Basic Concepts: Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Stability Analysis by Gain-phase Plots. Jump Resonance. Liapunov's Stability Analysis: Introduction, Liapunov's Stability Critrion: Basic Stability Theores, Liapunov Functions, Instability. Direct Method of Liapunov & the Linear System: Methods of constructing Liapunov functions for Non linear Systems. Book No. 2: 13.1 to 13.4; 15.1 to 15.10.

Text Book:

1. *Discrete-Time Control System, by K.Ogata, 2nd edition (2009), PHI.*
2. *Control Systems Engineering, by I.J. Nagrath and M.Gopal., 5th Edition (2007 / 2009), New Age International (P) Ltd. Publishers.*

Reference Book:

1. *Design of Feedback Control Systems by Stefani, Shahian, Savant, Hostetter, Fourth Edition (2009), Oxford University Press.*
2. *Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.*
3. *Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008), Pearson Education Inc. Publication.*
4. *Control Systems (Principles & Design) by M.Gopal, 3rd Edition (2008), Tata Mc.Graw Hill Publishing Company Ltd.*
5. *Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.*

PEE6J005 ADVANCE DIGITAL SIGNAL PROCESSING

Module:-1

Multirate Digital Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate Conversion by a rational factor I/D, Implementation of Sampling rate Conversion, Multistage implementation of Sampling rate Conversion, Sampling rate Conversion of Band pass Signals, Sampling rate Conversion by an Arbitrary Factor, Digital Filter Banks, Two-channel Quadrature Mirror Filter Bank.

Module:-2

Linear Prediction and Optimum Linear Filters: Random Signals, Correlation Functions, and Power Spectra , Innovation Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the normal equations: The Levinson-Durbin Algorithm. Properties of the Linear Prediction Error filters. Wiener filters for filtering and Prediction.

Adaptive Filters: Applications of Adaptive filters, Adaptive Direct-Form FIR filters- The LMS Algorithm.

Module:-3

Power Spectrum Estimation: Estimation of Spectra from Finite Duration Observations of Signals, Nonparametric Methods for Power Spectrum estimation, Relationship between the Autocorrelation and the model parameters. Bayes Theorem, Maximum Likelyhood detection.

Module:-4

The Yule-Walker Method for the AR Model Parameters, The Burg Method for the AR model Parameters, Unconstrained Least-Squares Method for the AR model parameters, MA Model for Power Spectrum Estimation, ARMA model for Power Spectrum Estimation.

Additional Module (Terminal Examination-Internal)

Filter Bank Methods, Eigenanalysis Algorithms for Spectrum Estimation

Text Book:

1. *Digital Signal Processing, John G.Proakis, Dimitris G. Manolakis, Pearson Education, New Delhi, 4th Edition, 2013.*

Reference Book:

1. *Adaptive Filter Theory, Simon Haykin, Pearson Education, 5th Edition 2017.*
2. *Adaptive Signal Processing, Bernard Widrow, Samuel D Stearns, Pearson Education,*

PMG6M001 ENVIRONMENTAL SCIENCE AND ENGINEERING

Module I

Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness.

Natural Resources:

Renewable and non-renewable resources:

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resoureces for sustainable lifestyles.

Module II

Ecosystems

Concept of an ecosystem.

- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following ecosystem :-

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Environmental Pollution Definition

- Cause, effects and control measures of :-

a) Air pollution
b) Water pollution
c) Soil pollution
d) Marine pollution
e) Noise pollution
f) Thermal pollution
g) Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution.
- Pollution case studies.

- Disaster management: floods, earthquake, cyclone and landslides.

Module III

Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rahabilitation of people; its problems and concerns. Case Studies
- Environmental ethics : Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
- Wasteland reclamation.
- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation.
- Public awareness.

Module IV

Human Population and the Environment

- Population growth, variation among nations.
- Population explosion – Family Welfare Programme.
- Environment and human health.
- Human Rights.
- Value Education.
- HIV/AIDS.
- Women and Child Welfare.
- Role of Information Technology in Environment and human health.
- Case Studies.

References

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. R. Rajagopalan, Environmental Studies, Oxford University Press
3. Ajith Sankar, Environmental Mangement, Oxford University Press
4. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
5. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
6. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
7. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
8. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
9. Down to Earth, Centre for Science and Environment (R)

PEN6E101 BUSINESS COMMUNICATION AND SKILL FOR INTERVIEW

Course Objectives

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To install Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

MODULE I

Communication Skill: Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

MODULE II

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

MODULE III

Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

MODULE IV

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

Expected outcome:

The students will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview & group discussion.
- Critically think on a particular problem.
- Solve problems.

- Work in Group & Teams
- Handle Engineering Ethics and Human Values.
- Become an effective leader.

References:

1. Barun K. Mitra; (2011), "Personality Development & Soft Skills", First Edition; Oxford Publishers.
2. Kalyana; (2015) "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd.
3. Larry James (2016); "The First Book of Life Skills"; First Edition; Embassy Books.
4. Shalini Verma (2014); "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company
5. John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

PEE6D001 SPECIAL ELECTROMECHANICAL DEVICES (HONORS) (4-0-0)

Module- I **[12 HOURS]**
University Portion (80%):

STEPPER MOTOR(6 hours)
Variable Reluctance (VR) Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor (HSM), Windings in Stepper Motor, Torque Equation, Characteristics of Stepper Motor, Open Loop Control of Stepper Motor, Closed Loop Control of Stepper Motor, Comparison of Stepper Motor, Application of Stepper Motor. Ch.1.1 to 1.9, Ch. 1.11, Ch. 1.12
SWITCHED RELUCTANCE MOTOR (SRM) (5 hours)
Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensor, Current Regulators Ch.2.1 to 2.9

Module- II **[10 HOURS]**
University Portion (80%): (9 Hours)

Permanent Magnet DC (PMDC) Motors: Construction, Principle of Working, Torque Equation and Equivalent Circuit, Performance Characteristics, Moving Coil (MC) Motors, Printed Circuit (PC) Motors, Shell Type PMDC Motors, Disc Motors
Ch. 3.1 (3.1.1 to 3.1.8)
Brushless Permanent Dc (BLDC) Motors: Classification of BLDC Motors, Construction, Electronic Commutation, Principle of Operation, Type of BLDC Motor, Control of BLDC Motor, Microprocessor Based Control of BLDC Motor, DSP Based Control of BLDC Motor, Sensor less Control of BLDC Motor, Comparison of Conventional DC Motor and BLDC Motor, Application of BLDC Motor
Ch. 3.2 (3.2.1 to 3.2.4, 3.2.6 to 3.2.12)

Module- III **[8 HOURS]**
University Portion (80%):
PERMANENT MAGNET SYNCHRONOUS MOTOR (PMSM) (4 hours)
Construction, Principle of Operation, EMF Equation of PMSM, Torque Equation, Phasor Diagram, Circle Diagram of PMSM, Comparison of Conventional and PM Synchronous Motor, Application of PMSM
Ch. 4.1 to 4.7, 4.9
SYNCHRONOUS RELUCTANCE MOTOR (SyRM)(3hours)
Construction of SyRM, Working of SyRM, Phasor Diagram and Torque Equation of SyRM, Control of SyRM, Advantages of SyRM, Applications of SyRM
Ch. 5.1 to 5.6

MODULE- IV **[10 HOURS]**

University Portion (80%):(9 Hours)

LINEAR ELECTRIC MACHINES

Linear Induction Motor (LIM): Construction of LIM, Thrust equation of LIM, Performance Equation Based on Current Sheet Concept, Goodness Factor, Equivalent Circuit of LIM, Characteristic of LIM, Certain Design Aspects of LIM, Control of LIM.

Linear Synchronous Motor (LSM): Type and Construction of LSM, Thrust equation of LSM, Control of LSM, Application of LSM.

DC Linear Motor (DCLM): Type and Construction of DCLM, Persistent Current Tubular Electromagnetic Launcher, Induction Tubular EML, DC Pulsed Flat Series EML, DC Tubular Series EML.

Ch. 8.1(8.1.1 to 8.1.8), Ch. 8.2(8.2.1 to 8.1.4), Ch. 8.3(8.3.1 to 8.3.6)

Text Book:

1. *Special Electric Machines – E.G.JANARDANAN – PHI Learning Pvt. Ltd,.*

Reference Book(s):

1. *Special Electric Machines –K. VENKATARATNAM- Universities Press Pvt. Ltd.*
2. *Electromechanical System and Devices- Sergey E. Lyshevski-CRC Press*
3. *Linear Motion Electromagnetic Devices- I.Boldea, S.A. Nasar-Taylor and Francis*

PEE6D002 FLEXIBLE AC TRANSMISSION SYSTEMS (HONORS) (4-0-0)

Module-I **[12 Hours]**

FACTS concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Description and Definitions of FACTS Controllers.

Static Shunt Compensation: Objectives of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators, SVC and STATCOM.

(Chapter-1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7)

(Chapter-5: 5.1, 5.2 and 5.3)

Module-II **[12 Hours]**

Static Series Compensators: Objective of Series Compensation (GCSC, TSSC, TCSC), Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (SSSC) Static Voltage and Phase Angle Regulators: Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs).

(Chapter-6: 6.1, 6.2 and 6.3)

(Chapter-7: 7.1 and 7.2)

MODULE-III **[10 Hours]**

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), The Interline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers.

(Chapter-8: 8.1, 8.2, 8.3 and 8.4)

Text book:

1. *"Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems" By N.G.Hingorani & L.Gyugyi, IEEE Press, Standard Publishers Distributors, Delhi.*

Reference Book:

1. *Facts Controllers in Power Transmission & Distribution by K.R.Padiyan, New Age Intermational.*
2. *Modelling & Simulation in Power Networks, Enrique Acha, Clandio Esquival & H.A.Perez,CA Camcho, John Wiley & Sons.*

PEE6D003 UTILIZATION OF ELECTRICAL ENERGY (HONOR) (4-0-0)

UNIT I: ELECTRIC DRIVES

Basic concept of electric drives, choice of electric drives, fundamental torque equation, speedtorque converter and multi quadrant operation, equivalent values of drive parameters, concept of load torque, calculation of time and energy loss in transient operation, steady state stability and load equalization,types of industrial loads, continuous, intermittent and variable loads,Review of torque speed characteristicsof AC and DC motors.

UNIT II: ILLUMINATION

Production of light - lighting calculations - determination of MHCP and MSCP - Polar curves of different types of sources - Rousseau's construction - photometers - interior and exterior illumination systems - lighting schemes - Design of lighting schemes - factory lighting - flood lighting - electric lamps - gaseous discharge lamps

UNIT III: HEATING AND WELDING:

Salient features of electric heating, resistance heating, induction heating, electric arc heating, methods of generating high frequency power.Arc Furnaces - Construction and fields of application - control equipment, Electric welding, resistance and arc welding, control devices and welding equipment, butt welding, spot welding. ;

UNIT IV: ELECTRIC TRACTION

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking.

Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.Recent trend in electric traction

TEXT BOOKS:

1. Utilisation of Electric Energy – by E. Openshaw Taylor, Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Utilization of Electrical Power including Electric drives and Electric traction – by

N.V.Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.
3. S. C. Tripathy, Electric Energy Utilisation and Conservation, Tata McGraw Hill, 1991.
4. W. F. Stocker and J.W. Jones, Refrigeration & Air Conditioning, McGraw Hill, 1985.
Supplementary Reading:
5. N.V. Suryanarayana, Utilisation of Electric Power, Wiley Eastern Ltd., 1993.

PEE6G001 ELECTRICAL MACHINES-II (MINOR)(4-0-0)

Module-I
University Portion (80%):
General principles of DC machines: Armature Windings (Simplex Lap and Simplex Wave), Expression for EMF Induced and Torque developed in the Armature counter Torque and Counter or Back EMF, Methods of Excitation, Armature Reaction, Commutation.
DC Machine Characteristics: Conditions for Self Excitation, Critical Resistance and Critical Speed. Internal and External Characteristics for self and Separately Excited DC Generator. Characteristic for Speed~ Armature Current, Torque~ Armature Current and Speed~ Torque of a DC Shunt, Series and Compound Motor and Comparison.

Module-II
University Portion (80%):
DC Motor Starting and Performance: Necessity of a Starter, Starting of DC Shunt, Series and Compound Motors, Speed Control of DC Shunt and Series motor Losses, efficiency and power flow diagram.
Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Internal Generated Voltage of a Synchronous Generator, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance).
Cylindrical Rotor type Three Phase Synchronous Generators: The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance, The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method
.

Module-III
University Portion (80%):
Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactance, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of Direct axis and Quadrature axis Reactance.
Parallel operation of Three Phase A.C. Synchronous Generators.The Conditions Required for Paralleling, The General Procedure for Paralleling Generators, Frequency - Real Power and Voltage – Reactive Power Characteristics of a Three Phase Synchronous Generator.

Module-IV

University Portion (80%):

Three Phase Synchronous Motors: Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting Synchronous Motors, Synchronous Generators and Synchronous Motors, Operation of synchronous motors connected to bus and phasor diagrams for normal, under and over excited conditions, V and Λ curves, Synchronous Motor Ratings. Application.

Special Purpose Motors: The Universal series motor: constructional features and performance characteristics

Text books:

1. *Stephen J. Chapman-'Electric Machinery and Fundamentals'- Mc Graw Hill International Edition, (Fourth Edition), 2015.*
2. *M.G.Say-'Alternating Current Machines', English Language Book Society (ELBS)/ Longman , 5th Edition, Reprinted 1990.*
3. *Electrical Machines – Prithwiraj Purkait & Indrayudh Bandyopadhyay, Oxford University Press*

Reference books:

1. *B.S.Guru & H.R.Hiziroglu-'Electric Machinery & Transformers'-3rd Ed-Oxford Press, 2014.*
2. *P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, John Wiley and Sons, Wiley India Reprint, 2014.*
3. *A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition Mc Graw Hill – Reprint 2015.*
4. *D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition Mc Graw Hill – Reprint 2015.*
5. *P S Bimbhra – Electrical Machinery –Khanna Publishers.*

PEE6G002 CONTROL SYSTEM ENGINEERING-II (MINOR) (4-0-0)

Module-I **[15 Hours]**

Discrete - Time Control Systems :

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process.

Digital Control Systems: Sample and Hold, Analog to digital conversion, Digital to analog conversion.The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorms of the Z-transform. The inverse Ztransform, Z Transform method for solving Difference Equations.

Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorm, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and

Routh stability critgion, Jury stability Test. Book No. 1: 1.1; 1.2; 1.4; 2.1; 2.2; 2.3; 2.4; 2.5; 2.6; 3.2; 3.4; 3.5; 4.2; 4.3.

Module -II **[15 Hours]**

State Variable Analysis & Design:

Introduction: Concepts of State, State Variables and State Model (of continuous time systems): State Model of Linear Systems, State Model for Single-Input-Single-Output Linear Systems, Linearization of the State Equation. State Models for Linear Continuous – Time Systems: State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors.

Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Effect of Pole-zero Cancellation in Transfer Function. Pole Placement by State Feedback, Observer Systems. State Variables and Linear Discrete – Time Systems: State Models from Linear Difference Equations/z-transfer Functions, Solution of State Equations (Discrete Case), An Efficient Method of Discretization and Solution, Linear Transformation of State Vector (Discrete-Time Case), Derivation of z-Transfer Function from Discrete-Time State Model. Book No. 2: 12.1 to 12.9.

Module -III **[12 Hours]**

Nonlinear Systems :

Introduction : Behaviour of Non linear Systems, Investigation of nonlinear systems. Common Physical Non Linearities: Saturation, Friction, Backlash, Relay, MultivariableNonlinearity. The Phase Plane Method: Basic Concepts, Singular Points: Nodal Point, Saddle Point, Focus Point, Centre or Vortex Point, Stability of Non Linear Systems: Limit Cycles, Construction of Phase Trajectories: Construction by Analytical Method, Construction by Graphical Methods. The Describing Function Method: Basic Concepts: Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Stability Analysis by Gain-phase Plots. Jump Resonance. Liapunov's Stability Analysis: Introduction, Liapunov's Stability Critrion: Basic Stability Theores, Liapunov Functions, Instability. Direct Method of Liapunov & the Linear System: Methods of constructing Liapunov functions for Non linear Systems. Book No. 2: 13.1 to 13.4; 15.1 to 15.10.

Text Book:

3. *Discrete-Time Control System, by K.Ogata, 2nd edition (2009), PHI.*
4. *Control Systems Engineering, by I.J. Nagrath and M.Gopal., 5th Edition (2007 / 2009), New Age International (P) Ltd. Publishers.*

Reference Book:

6. *Design of Feedback Control Systems by Stefani, Shahian, Savant, Hostetter, Fourth Edition (2009), Oxford University Press.*
7. *Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.*
8. *Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008), Pearson Education Inc. Publication.*
9. *Control Systems (Principles & Design) by M.Gopal, 3rd Edition (2008), Tata Mc.Graw Hill Publishing Company Ltd.*
10. *Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.*

Seventh Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/Week L/T**	**Credit Theory**	**University marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Soft Computing	3-0	3	100	50	2	1	50
PE	Switch gear and Protective Devices/ Biomedical Instrumentation/mobile Communication	3-1	4	100	50			
PE	Communication Engineering / Digital Image Processing / Adaptive Control	3-1	4	100	50			
OE	Power Station Engineering & Economy / Marketing Management / Production & Operation Management/ Computer Vision	3-1	4	100	50			
PC	Advanced Electrical Computational Lab-II/ Project					8	4	150
OE	Industrial Lecture #					3	2	50
HS	Preparing for Interview #	1-0	1		50	3	2	100
Total		16	16	400	250	16	9	350
Total Marks:1000								
Total Credits:24								
Honors Paper	High Voltage Engineering./ Electrical Power Quality/ Smart Grid/ PLC & SCADA	4	4	100	50			
Minor	Power Station Engg. & Economy	4	4	100	50			

Semester : 7th

1.	PEE7C001	GS(CP)	Nano & Bioscience	4-0-0	4
2.	PEE7D001	Honours(CP)	Computational Number Theory	4-0-0	4
3.	PEE7H001	OE(O4)	Soft Computing	4-0-0	4
4.	PEE7H002	OE(O4)	Other subjects	4-0-0	4
5.	PEE7H201	FE(CP)	Projects on Internet of Things	0-0-4	4
6.	PEE7I201	PC(O3)	Advance Lab - II	0-0-4	4
7.	PEE7I202	PC(O3)	Project	0-0-4	4
8.	PEE7J001	PE(O1)	Switch Gear & Protective Devices	4-0-0	4
9.	PEE7J002	PE(O1)	Biomedical Instrumentation	4-0-0	4
10.	PEE7J003	PE(O1)	Mobile Communication	4-0-0	4
11.	PEE7J004	PE(O2)	Communication Engineering	4-0-0	4
12.	PEE7J005	PE(O2)	Digital Image Processing	4-0-0	4
13.	PEE7J006	PE(O2)	Adaptive Control	4-0-0	4
					28

SWITCH GEAR AND PROTECTIVE DEVICES

Module- I **[10 Hours]**

University Portion (80%) : (8 Hours)

Introduction: Principle and need for protective schemes, Nature and causes of faults, Zones of protection, Primary and back-up protection, Basic principle of operation of protective system, Components of Protection System.

[Text Book 1 : CH 1.1, 1.2, 1.5, 1.6, 1.7, 1.8, 2.1, 2.2, 2.3]

Sequence Components and Fault Analysis:Sequence components (positive, negative and zero) and their significance, Average 3-phase power in terms of symmetrical components, sequence impedance, fault calculations, Single line to ground fault, Line to ground fault with Zf, Faults in Power systems, Concept of short circuit capacity of a Bus.[Ref. Book 1: CH 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.10, 13.13]

Module- II **[10 Hours]**

University Portion (80%) : (8 Hours)

Operating Principles and Relay Construction: Relay design and construction, Relay classification, Types of Electromagnetic relays, Theory of Induction relay torque, General Equations of Comparators and Electromagnetic Relays, Over Current relays, Directional relays, Distance relays, Differential relays.

Feeder Protection:Over current, Distance and Pilot Protection.

Static Relays: (Comparators and different relays)

Amplitude comparator, Phase Comparator, Coincidence type phase comparator, Basic elements of a static relay, Over Current Relays, Differential Protection, Static distance Protection.

[Text Book 1: CH 3.1, 3.2, 3.3, 3.4, 4.2, 4.3, 4.4, 4.7, 4.8, 4.9, 5.2, 5.3, 5.4, 11.1, 11.2, 11.3, CH 12.1, 12.2, 12.3, 12.4]

Module- III **[10 Hours]**

University Portion (80%) : (8 Hours)

Apparatus Protection: Transformer Protection, Generator Protection, Motor Protection, Bus bar protection schemes. [Text Book 1: CH 6.2, 6.3, 6.4, 6.5]

Numerical relays: Block Diagram of Numerical Relay, Signal Sampling & Processing, Numerical Over-current protection, Numerical Transformer differential Protection, Numerical distance Protection of Transmission Line. [Text Book 2: CH 11.2, 11.3, 11.7, 11.8, 11.9]

Module- I V **[10 Hours]**

University Portion (80%) : (8 Hours)

Switchgears: Auto reclosing, Theory of Circuit interruption, Circuit constants in relation to Circuit breaking, Re-striking voltage transient, characteristics of Re-striking Voltage, Interaction between breaker and circuit, Current chopping.

Circuit Breakers: Types of circuit breakers (air blast, air break, oil, vacuum, SF6 , DC circuit breaker), advantages and testing of circuit breaker.[Text Book 1: CH 7.1, 7.2, 7.3, 7.4, CH 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 14.2,14.3, 14.4, 14.5, 14.6, 14.7, 15.2, 15.3, 15.5, 16.2, 16.3, 16.4, 18.2, 18.5, 18.6, 18.7, 18.8]

Text Books:

1. *Power System Protection and Switchgear – B.Ravindranath & M.Chander–New Age International Publishers (Second Edition).*
2. *Bhavesh Bhalja, R P Maheshwari, Nilesh G.Chothani, Oxford University Press*
3. *Fundamentals of Power System Protection – Y.G.Paithankar and S.R.Bhide, PHI Publication. (Second Edition)*

Reference Books:

1. *Electrical Power System - C.L.Wadhwa New Age International Publishers. (Sixth Edition).*
2. *Power System Engineering - M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, Dhanpat Rai & Co. (P) Ltd.*
3. *Protection and Switchgear - B.Bhalja, R.P.Maheshwari, N.G. Chothani, OXFORD University Press.*
4. *Power System Protection and Switchgear - Badri Ram, Vishwakarma, Tata McGraw hill.*
5. *Switchgear and Protection – Sunil S Rao , Khanna Publishers, New Delhi.*
6. *Power System relaying by Horwitz, Phadke, Research Press.*

POWER STATION ENGINEERING & ECONOMY

Module-I **[10 Hours]**

University Portion (80%):

Introduction (1 hour)

Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario. (Nag-1.5)

Prediction of Load (2 hours)

Connected Load, Maximum Load, Demand Factor, Average load, Load Factor, Load duration curves,Diversity Factor, Choice of Type of Generation, Capacity Factor, Reserve Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants. (Nag-1.2)

Economics of power generation (5 hours)

Cost of Electrical Energy, Construction costs, Fixed cost, Costs for Energy, Depreciation of Plant, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh, Tariff or Charge to Consumer. (Nag-1.4, Deshpande-2.2, 2.3, 2.6, 2.7, 2.8, 2.9)

Module-II **[8 Hours]**

University Portion (80%):

Nuclear power station (6 hours)

Introduction to fission & fusion, Principle of Nuclear Energy, Reactor Construction, Controlled Chain Reaction, Brief study of various Types of Power Reactor, Operational Control of Reactors, Location and layout of nuclear power plant ,Economics of Nuclear Power Station. (Nag- 9.5, 9.6, 9.13, 9.15 - 9.21, Deshpande-6.2, 6.3, 6.4, 6.5, 6.6, 6.9, 6.13)

Module-III[10 Hours]

University Portion (80%):

Hydro Electric power station: (2 hours)

Selection of site for hydro-electric power plant. (Nag-10.4)

Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored by a dam across the river,Storage and Pondage, Elementary idea about Earthen and Concrete Dam. (Deshpande-7.2, 7.3, 7.4, 7.5, 7.6, Nag – 10.5 - 10.7)

Types of Turbines: (3 hours)

Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done and Efficiency .(Nag- 10.10 – 10.15, 10.24 - 10.25,Deshpande-8.3)
Arrangement and location of Hydroelectric Station: (3 hours)
Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants. (Deshpande-7.7, Nag-10.8, 10.9) Governors, Plant auxiliaries. (Nag – 10.21)

Module-IV [10 Hours]

University Portion (80%):

Thermal power station: (3 hours)
Selection of site for thermal power plant. (Nag-1.3)
Main Parts and Working of a Steam Station:
Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Re-heater, Air Pre-heater. (Vopat – 7.4, Chap-8, Chap-10, Nag-2.15, 6.3.1, 6.3.2, 6.4-6.6, 6.8, 6.12 - 6.15)
Draft System: (3 hours)
Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney. (Vopat – 9.1, 9.4, Nag- 4.14.1, 4.14.3, 4.15)
Condensers, Feed water heaters, Evaporators, Make-up water, bleeding of steam, cooling water system. (Vopat- 14.1, 14.6, 18.2, 18.13, Nag – 8.1- 8.6)
Electrostatic Precipitator: (2 hours)
Basic working Principle and constructional details Governors, Plant auxiliaries. (Nag-6.10, Vopat- 12.14)

Text books:

1. *P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication.*
2. *M. V. Deshpande, "Elements of Electrical Power Station Design", PHI .*
3. *Bernhardt G. A. Skrotzki, William A. Vopat, "Power Station Engineering and Economy", 2nd Edition, Tata McGraw Hill Publication.*

References Books:

1. *Arora &Domkundwar, "A Course in Power Plant Engineering", Dhanpat Rai and sons.*
2. *R. K. Rajput, "A Text Book of Power Plant Engineering", 3rd Edition, Laxmi Publishing.*

HIGH VOLTAGE ENGINEERING

Module-I [8 Hours]

University Portion (80%): (7 Hours)

Generation of high voltage, Generation of high direct current- voltage, Alternating Current-voltage, Impulse voltage and Impulse currents. [Text Book 1:6.1, 6.2,6.3]

Module-II [12 Hours]

University Portion (80%): (10 Hours)

Electrical breakdown in gas solid and liquid, Collision processes, Gaseous breakdown in uniform and non-uniform fields and corona. Ionisation process. Townsend's current growth equation. Townsend's criterion for breakdown. Determination of coefficients α and γ. Streamer's theory of breakdown in gases. Paschen's Law. Conduction and breakdown in pure and commercial liquid. Breakdown mechanism in solid and dielectric

[Text Book 1:2.2, 2.3, 2.4, 2.6, 2.7, 2.10, 2.11, 2.12, 3.4]

Module-III **[12 Hours]**

University Portion (80%): (10 Hours)

Study of over voltage in electrical power system and measurement of high voltage :
Causes of overvoltage and its effect on power system. Lightning and switching surges and temporary high voltage, protection against over voltage. Measurement of high voltage and high current. [Text Book 1:8.1,8.2]

Module-IV **[8 Hours]**

University Portion (80%): (7 Hours)

High voltage testing and insulation coordination
High voltage testing of electrical apparatus [Insulator, Bushing, Isolator, Circuit breaker, Transformer, Surge Arrester, Cable] [Text Book 1:10.1, 10.2, 10.3, 10.4, 10.5]

Text book:

1. *M.S Naidu and V. Kamaraju, 'High Voltage Engineering'. Tata McGraw Hill,6th Edition 2015.*

Reference book:

2. *:E. Kuffel and W. S Zaengel,' High voltage engineering Fundamentals', Pergamon Press Oxford, London, 1986*

ELECTRICAL POWER QUALITY

Module-I **[12 Hours]**

Terms & Definitions: General Classes of Power Quality Problems, Transients, Long Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuations, Power Frequency Variations, Power Quality Terms.
Voltage Sags & Interruptions: Sources of Sags and Interruptions, Estimating Voltage Sag Performance, Fundamental Principles of Protection, Solutions at the End-User Level, Evaluating the Economics of Different Ride-Through Alternatives, Motor Starting Sags, Utility System Fault-Clearing Issues.
(Chapter-2: 2.2 to 2.10 and Chapter-3: 3.1 to 3.7)

Module-II **[12 Hours]**

Transient Over Voltages: Sources of Transient Over Voltages, Principle of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor-Switching Transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transient Analysis.
Fundamentals of Harmonics: Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Locating Harmonic Sources, System Response Characteristics, Effects of Harmonic Distortion, Inter-harmonics.
(Chapter-4: 4.1 to 4.8 and Chapter-5: 5.1 to 5.11)

Module-III **[10 Hours]**

Long Duration Voltage Variations: Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator Application, Capacitors for Voltage Regulation, End-User Capacitor Application, Regulating Utility Voltage with Distributed resources, Flicker.

Power Quality Monitoring: Monitoring Considerations, Historical Perspective of Power Quality Measuring Instruments, Power Quality Measurement Equipments, Assessment of Power Quality Measurement Data, Application of Intelligent Systems, Power Quality Monitoring Standards.
(Chapter-7: 7.1 to 7.7 and Chapter-11: 11.1 to 11.6)

Text book:

1. *"Electrical Power Systems Quality" By Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso & H.Wayne Beaty, 2nd Edition, TMH Education Private Ltd., New Delhi.*

Reference Book:

1. *Power System Quality Assesment, J.Arrilaga, N.R.Watson, S.Chen, John Wiley & Sons.*
2. *Understanding Power Quality Problems: Voltage Sags & Interruptions, M.H.J. Boller IEEE, 1999*

DIGITAL IMAGE PROCESSING

MODULE-I

Fundamentals – Steps in digital image processing, sampling and quantization, relationship between pixels, imaging geometry

Image Transforms – Fourier Transform, Discrete Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Walsh Transform, Hadamard Transform, Hotelling Transform.

MODULE-II

Image Enhancement – Point processing, spatial filtering (smoothing and sharpening filters), enhancement in frequency domain.

Filtering in the Frequency Domain: preliminary concepts, 2D DFT and its properties,basic filtering in the frequency domain, image smoothing and sharpening.

MODULE-III

Image Restoration and Reconstruction: Image restoration/degradation model, noisemodels, restoration in the presence of noise only, estimating the degradation function.

Color Image Processing: Color models, Color transformation.

MODULE-IV

Wavelets and Multi-resolution Processing: multiresolution expansions, wavelettransforms in one and two dimension.

Image Compression: Fundamentals, Some basic compression methods (Chapt: 8 ofText book 1)

Text books

1) Digital Image Processing, R.C. Gonzalez, R.E. Woods, Pearson Education , 3rd Edition, 2007
2) Digital Image Processing, S. Sridhar, Oxford University Press,2011
3) Digital Image Processing And Analysis, B. Chanda, Dutta D. Majumder ,PHI

Reference Books

1) Digital Image Processing using MATLAB, Rafael C. Gonzalez, Richard E. Woods Pearson Education, Inc., Seventh Edition, 2004.
2) Digital Image Processing, S. Sridhar, Oxford University Press,2011
3) Digital Image Processing, William K. Pratt, John Wiley, New York, 2002

ADAPTIVE SIGNAL PROCESSING

MODULE–I (10 Hours)

Introduction: Adaptive Systems – Definition and characteristics, General properties, Open and Closed Loop Adaptations, Applications.

The Adaptive Linear Combiner: Performance function, Gradient and Mean Square Error, Examples.

MODULE – II (14 Hours)

Theory of Adaptation with Stationary Signals: Properties of the Quadratic Performance Surface, Significance of eigen values, eigen vectors, correlation matrix.

Searching the Performance Surface: A simple gradient search algorithm, Stability and Rate of convergence, the learning curve.

MODULE-III (16 Hours)

Gradient Estimation and its effects on Adoption: The performance penalty, Variance of the gradient estimate, Misadjustment.

Adaptive Algorithms and Structures: The LMS Algorithm, Convergence, learning Curve, Performance analysis, Filtered X LMS algorithm,

MODULE-IV

Applications: Adaptive Modelling and System Identification using adaptive filter, Inverse Adaptive Modelling, Deconvolution, and equalization using adaptive filter.

Text Books

1. *Adaptive Signal Processing*, Bernard Widrow and Samuel D. Stearns, Pearson Education, 2nd impression, 2009.

Reference Books

2. *Adaptive Filter Theory*, Simon Haykin, Pearson Education, 4th Edn.

BIOMEDICAL INSTRUMENTATION

University level: 80%

Module I (13 Hours)

Introduction to Bioengineering, Biochemical Engineering, Biomedical Engineering, Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices.

Bioelectrical Signals & Electrodes: Origin of Bioelectric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.

Module -II (14 Hours)

Electrodes for ECG: Limb Electrode, Floating Electrodes, Prejelled disposable Electrodes, Electrodes for EEG, Electrodes for EMG.

Physiological Transducers: Introduction to Transducers, Classification of Transducers, Performance characteristics of Transducers, Displacement, Position and flow and pressure Transducers.

Strain gauge pressure transducers, Thermocouples, Electrical Resistance Thermometer, The mister, Photovoltaic transducers, Photo emissive Cells & Biosensors or Biochemical sensor

Module –III (13 Hours)

Recording Systems: Basic Recording systems, General considerations for Signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrostatic and Electromagnetic Coupling to AC Signals, Proper Grounding (Common Impedance Coupling)
20% Course (Institute Level)

Transformation techniques in biomedical signals ie. Laplace transform, Z-transform, DFT, DTFT, STFT, Wavelet transform, Effects of noise in biomedical instruments- filtering in biomedical instruments.

Text Books:-

1. *Hand Book of Biomedical Instrumentation-2nd Ed by R.S.Khandpur, Tata McGraw Hill, 2003*
2. *Introduction to Biomedical Engineering by Michael M. Domach, Pearson Education Inc,-2004*

Reference Books:

(1) *Introduction to Biomedical equipment technology, 4e. By JOSEPH.J.CAAR & JOHN M.BROWN (Pearson education publication)*

(2) *Medical Instrumentation-application & design. 3e – By JOHN.G.WEBSTER John Wiley & sons publications*

SOFT COMPUTING

MODULE – I (8 hours)

Basic tools of soft Computing: Fuzzy logic, Neural Networks and Evolutionary Computing, Approximations of Multivariate functions, Non – linear Error surface and optimization.

MODULE – II (8 hours)

Fuzzy Logic Systems: Basics of fuzzy logic theory, Crisp and fuzzy sets; Basic set operations; Fuzzy relations, Composition of Fuzzy relations, Fuzzy inference, Zadeh's compositional rule of inference; Defuzzificaiton ; Fuzzy logic control; Mamdani and Takagi and Sugeno architectures. Applications to pattern recognition.

MODULE—III (16 hrs)

Neural networks: Single layer networks, Perceptron; Activation functions; Adalinc- its training and capabilities, weights learning, Multilayer perceptrons; error back propagation, generalized delta rule; Radial basis function networks and least square training algorithm, Kohenen self – organizing map and learning vector quantization networks; Recurrent neural networks, Simulated annealing neural networks; Adaptive neuro-fuzzy information; systems (ANFIS),

MODULE—IV (08 hrs)

Evolutionary Computing: Genetic algorithms: Basic concepts, encoding, fitness function, reproduction. Differences of GA and traditional optimization methods. Basic genetic, basic evolutionary programming concepts Applications, hybrid evolutionary algorithms.

Text Books

1) *F. O. Karry and C. de Silva, "Soft Computing and Intelligent Systems Design – Theory, Tools and Applications". Pearson Education. (Printed in India).*

Reference Books

2) J. S. R. Jang. C. T. SUN and E. Mizutani, "Neuro-fuzzy and soft-computing". PHI Pvt. Ltd., New Delhi.

3) Fredric M. Ham and Ivica Kostanic, "Principle of Neuro Computing for Science and Engineering", Tata McGraw Hill.

4) S. Haykins, "Neural networks: a comprehensive foundation". Pearson Education, India.

5) V. Keeman, "Learning and Soft computing", Pearson Education, India.

6) R. C. Eberhart and Y. Shi, "Computational Intelligence Concepts to Implementation". Morgan Kaufmann Publishers (Indian Reprint).