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								
Honours	Electrical Engineering Materials	4	4	100	50			
Minor	Electrical and Electronics Measurement/ Electromagnetic Theory							

Semester : 3rd

1.	PEL3D001 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.	PEL3G001 Minor(O3)	Electrical and Electronics Measurement	4-0-0	4
5.	PEL3G002 Minor(O3)	Electromagnetic Theory	4-0-0	4
6.	PEL3I001 PC(CP)	Electromagnetic Theory	4-0-0	4
7.	PEL3I101 PC(CP)	Network Theory	3-0-1	4
8.	PEL3I102 PC(CP)	Analog Electronic Circuits	3-0-1	4
9.	PEL3I103 PC(CP)	Electrical Machines - I	3-0-1	4
10.	PEL3I104 PC(CP)	Electrical & Electronics Measurement	3-0-1	4

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PEL3I101 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.*

PEL3I103 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.

College/Institute Portion (20%):

Qualitative explanation for origin of harmonic current and voltage and its suppression. Inrush of switching currents, magnetizing current wave form or related advanced topics as decided by the concerned faculty teaching the subject.

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 (0^o, 180^o, $+30^o$ and -30^o), Connection Diagrams and Phasor Diagrams of various Vector Groups (Yy_0, Dd_0, Dz_0, Yy_6, Dd_6, Dz_6, Yd_1, Dy_1, Yz_1, Yd_{11}, Dy_{11}, and Yz_{11})

College/Institute Portion (20%):

3-winding transformer or related advanced topics as decided by the concerned faculty teaching the subject.

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.

College/Institute Portion (20%):

Brief Idea on Induction Generators, Different types of braking or related advanced topics as decided by the concerned faculty teaching the subject.

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.

College/Institute Portion (20%):

Selection of capacitor value during starting and running or related advanced topics as decided by the concerned faculty teaching the subject.

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.
6. *Speed control of a three phase induction motor using variable frequency drives*
7. *Determination of parameters of three phase induction motor from No load Test and Blocked Rotor Test.*
8. *Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase Induction motor by Brake Test.*
9. *Performance of grid connected induction generator.*
10. *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

PEL3I104 ELECTRICAL AND ELECTRONICS MEASUREMENT

Module- I **[10 Hrs]**

University Portion (80%): (8 Hrs)

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]

College/Institute Portion (20%): (2 Hrs)

Measuring instruments: Absolute and secondary instrument, indicating and recording instrument. Text Book-1- Ch-XVII. Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-II **[10 Hrs]**

University Portion(80%): (8 Hrs)

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]

College/Institute Portion (20%): (2 Hrs)

Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Torque meters, inductive torque transducers, electric tachometers, photo-electric tachometers, Hall Effect Transducer. (Text Book-2- Ch-11.1 to 11.6). Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- III **[10 Hrs]**

University Portion (80%): (8 Hrs)

1. 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.
2. 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]

College/Institute Portion (20%): (2 Hrs)

pH- Meter, volt ratio boxes and other auxiliary apparatus. Text Book-1- Ch- VIII. Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- IV **[10 Hrs]**

University Portion(80%): (8 Hrs)

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

1. 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
2. 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]

College/Institute Portion (20%): (2 Hrs)

[Wave analyser and Counter. (Text Book-2- Ch- 9.2,9.3,9.4,10.1)]. Or related advanced topics as decided by the concerned faculty teaching the subject.

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.*

ELECTRICAL AND ELECTRONICS MEASUREMENT LAB

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.*

PEL3I001 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)

College/Institute Portion (20%):

Field: Scalar Field and Vector Field. Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%):

Nature of current and current density, the equation of continuity. Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%): (2 hours)

Energy in Magnetic Field Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%):

General Wave Equation, Plane wave in dielectric medium, free space, a conducting medium, a good conductor and good dielectric, Polarization of wave. Or related advanced topics as decided by the concerned faculty teaching the subject.

Text Book:

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

Reference Book:

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

PEL3D001 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. *A. J. Dekker, 'Electrical Engineering Materials', Prentice hall of India, India*
2. *C. 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*

PEK3E001 ENGINEERING ECONOMICS

Theory L/T (Hours per week):2/1, Credit: 3

Module I (12 hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.

Demand- Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand & its measurement (Simple numerical problems to be solved), Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Production-Production function, Laws of returns: Law of variable proportion, Law of returns to scale

Module II (12 hours)

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

Module III (12 hours)

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects .

Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation (Straight line method, Declining balance method), After tax comparison of project.

Text Books

1. *Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India*
2. *Principles of Economics, Deviga Vengedasalam; Karunagaran Madhavan, Oxford University Press.*
3. *Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson*
4. *R.Paneer Seelvan, " Engineering Economics", PHI*
5. *Ahuja,H.L., "Principles of Micro Economics" , S.Chand & Company Ltd*
6. *Jhingan,M.L., "Macro Economic Theory"*
7. *Macro Economics by S.P.Gupta, TMH*

POB3E002 ORGANIZATIONAL BEHAVIOUR

Credit- 3 Class Hours - 40

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations
2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Unit	Contents	Class Hours
01	**Fundamentals of OB**: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.	6
02	**Attitude:** Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes. **Personality and values:** Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. **Perception:** Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect). **Motivation:** Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.	10
03	**Foundations of Group Behavior:** The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. **Managing Teams:** Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building. **Leadership:** Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.	9
04	**Organizational Culture** : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.	8

05	**Organizational Change:** Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change. Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change & Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.	**7**

Reference Books

1. *Understanding Organizational Behaviour, Parek, Oxford*
2. *Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.*
3. *Organizational Behaviour, K. Awathappa,HPH.*
4. *Organizational Behaviour, VSP Rao, Excel*
5. *Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.*
6. *Organizational Behaviour, Hitt, Miller, Colella, Wiley*

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 Systems Engg-I	3-0	3	100	50	2	1	50
PC	Digital Electronics Circuit	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								
Honours	Electronics Devices and Modelling/ Sensors & Transducers (E&I)	4	4	100	50			
Minor Specialization	Electrical Power Transmission & Distribution / Control System Engineering-I							

Semester : 4th

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1. PEL4D001 Honours(O2)	Electronics Devices and Modelling	4-0-0	4
2. PEL4D002 Honours(O2)	Sensor & Transducers	4-0-0	4
3. PMA4E001 HS(CP)	Applied Mathematics - III	3-0-0	3
4. PEK4E002 HS(O1)	Engineering Economics	3-0-0	3
5. POB4E003 HS(O1)	Organizational Behavior	3-0-0	3
6. PEL4G001 Minor(O3)	Transmission & Distribution System	4-0-0	4
7. PEL4G002 Minor(O3)	Control System Engineering - I	4-0-0	4
8. PEL4I101 PC(CP)	Electrical Machines - II	3-0-1	4
9. PEL4I102 PC(CP)	Control System Engineering - I	3-0-1	4
10. PEL4I103 PC(CP)	Digital Electronic Circuits	3-0-1	4
11. PEL4I104 PC(CP)	Electrical Power Transmission & Distribution	3-0-1	4
12. PEL4I201 PC(CP)	Skill Project and Hands on	0-0-3	3

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PEL4I101 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.

College/Institute Portion (20%):

Constructional features, Brush Shift and its Effects, Interpoles, Compensating Windings or related advanced topics as decided by the concerned faculty teaching the subject.

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

College/Institute Portion (20%):

Braking of Dc motor, Application, Zero Power Factor characteristic, Potier Reactance, Voltage Regulation by Potier Reactance (Zero Power Factor = ZPF) Method or related advanced topics as decided by the concerned faculty member teaching the subject.

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.

College/Institute Portion (20%):
Operation of Generators in Parallel with large Power Systems, Operation of generators in parallel with other Generators of the same size or related advanced topics as decided by the concerned faculty member teaching the subject.

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
College/Institute Portion (20%):
Other types of Motors: Reluctance Motors, Stepper Motors or related advanced topics as decided by the concerned faculty member teaching the subject.

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*
    a. *Positive sequence reactance*
    b. *Negative sequence reactance*
    c. *Zero sequence reactance*
7. *Determination of power angle characteristics of an alternator*
8. *Study of parallel operation of two alternators*
9. *Measurement of direct and quadrature axis reactance of a salient pole synchronous machine*
10. *Measurement of transient and sub transient reactance of a salient pole alternator*

PEL4I102 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)
College/Institute Portion (20%): Control System and Components: Modeling of Stepper motor, AC & DC Servomotor, Synchros, AC Tachometer with selected problems.](Text Book-1-Ch 4.3, 4.4) Or any related topic as decided by the concerned faculty member teaching the subject.

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)

College/Institute Portion (20%):
Sensitivity of the Roots of the Characteristics Equation (Text Book-1-Ch- 7.6)] Or any related topic as decided by the concerned faculty member teaching the subject.

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)
College/Institute Portion (20%):
[Tuning Rules for PID controllers. (Text Book-2-Ch-10.2)] Or any related topic as decided by the concerned faculty member teaching the subject.

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 Synchros*

PEL4I104 ELECTRICAL POWER TRANSMISSION & DISTRIBUTION

Module-1
University portion (80%) (13 Hours)

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.

College/Institute portion-20%)

Corona: Critical Disruptive Voltage, Corona Loss, Disadvantage of Corona, Radio Interference, Inductive Interference between Power and Communication Lines**.** Or Related advanced topics as decided by the concerned faculty teaching the subject.

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

College/Institute portion (20%)

Load Estimation, Design of Primary Distribution, Sub-Stations, Secondary Distribution Design, Economical Design of Distributors, Design of Secondary Network, Lamp Flicker,

Application of Capacitors to Distribution Systems. Or Related advanced topics as decided by the concerned faculty teaching the subject

Module-4 (5 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.

College/Institute portion (20%) (1 Hour)

Tower Footing Resistance, Neutral Earthing**.** Or Related advanced topics as decided by the concerned faculty teaching the subject.

Text Books

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

Reference Books

1. *Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., 2008 Wiley India.*
2. *Electrical Power Systems-C. L. Wadhwa, New Age International Publishers, Sixth Edition.*
3. *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.*

PEL4D002 SENSORS AND TRANSDUCERS

Module -1

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)**

College/Institute Portion (20%): (1 hour)

[Techniques for dynamic compensation, Loading Effects and Two-port Networks **(Bentley: Sections 4.4 and 5.1-5.2)]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-2

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)**

College/Institute Portion (20%): (1 hour)

[RVDT, Hall Effect sensors **(Bentley: Sections 8.3 and 8.10)]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-3

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)**

College/Institute Portion (20%): (1 hour)

[Piezoelectric sensing elements, Piezoresistive sensing elements **(Bentley: Sections 8.7 and 8.8)]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-4

University Portion (80%): (8hours)

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)**

College/Institute Portion (20%): (1 hour)

[Current transmitters, Oscillators and resonators **(Bentley: Sections 9.4 and 9.5)]** Or related advanced topics as decided by the concerned faculty teaching the subject.

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,*
2. *International, NY.*
3. *Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G.*
4. *McConnel (2/e), John Wiley, NY, 2003.*
5. *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 System/Advanced Electronics Circuit	3-1	4	100	50			
OE	Optimization in Engineering	3-1	4	100	50			
PC	Advance Lab-I(Advanced Circuit Simulation Lab-I)					8	4	200
Total		17	17	500	250	14	7	350
Total Marks: 1100								
Total Credits: 24								
Honors	Electrical Machine Design/ Antennas and Wave Propagation	4	4	100	50			
Minor	Electrical Machines-I							

Semester : 5th

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1. PEL5D001 Honours(O4)	Electrical Machine Design	4-0-0	4
2. PEL5D002 Honours(O4)	Antennas and Wave Propagation	4-0-0	4
3. PEL5G001 Minor(CP)	Electrical Machines - I	4-0-0	4
4. PEL5H001 OE(CP)	Optimization in Engineering	4-0-0	4
5. PEL5I101 PC(CP)	Power Electronics	3-0-1	4
6. PEL5I102 PC(CP)	Microprocessor & Microcontroller	3-0-1	4
7. PEL5I103 PC(CP)	Digital Signal Processing	3-0-1	4
8. PEL5I201 PC(CP)	Advance Lab - I (Advanced Circuit Simulation Lab-I)	0-0-4	4
9. PEL5J001 PE(O3)	Renewable Energy Systems	4-0-0	4
10. PEL5J002 PE(O3)	Advanced Electronics Circuits	4-0-0	4

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PEL5I101 POWER ELECTRONICS

Module-1 (12 Hours)

University portion (80%): (10 Hours)

1. **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]**
2. **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]**
3. **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)**

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

Two-Transistor Model of SCR, V-I characteristics of RCT, MCT, **[Chapter: 7.3, 7.6.6, 7.6.12, 7.7, 7.8]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 2 (12 Hours)

University portion (80%): (10 Hours)

1. **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]**
2. **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]**

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

Effect of Source and Load Inductance, Single phase PWM rectifier, Three phase PWM rectifier. **[Chapter: 6.6,11.13]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 3 (8 Hours)

University portion (80%): (6 Hours)

1. **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]**

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

Multioutput boost converter, Diode rectifier-fed Boost converter **[Chapter: 5.10, 5.11]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 4 (8 Hours)

University portion (80%): (6 Hours)

1. **DC to AC converter: (4 Hours)**
   Inverters: Single phase Bridge Inverters, 3-Phase Inverters-180^0 mode conduction, 120^0 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]**
2. **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]**

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

Zero Current Switching, Zero voltage Switching technology in DC-DC converter, Zero Voltage Switching resonant inverter.**[Chapter: 8.8, 8.9]** Or related advanced topics as decided by the concerned faculty teaching the subject.

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*

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.*

PEL5I102 MICROPROCESSORS AND MICROCONTROLLER

MODULE-I (10 Hours)

University Portion (80%):

Introduction of Microcomputer System (08 Hours)

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)**

College/Institute Portion (20%): (02 Hours)

Logic diagram of the 74LS244 octal buffer. Logic diagram of the 2114 memory device.**(Book 2: 2.52, 2.56)** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-II (10 Hours)

University Portion (80%):

Instructions and programming of 8085 and 8086 (08 hours)

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)**

College/Institute Portion (20%): (02 Hours)

BCD to seven segment LED code conversion, microprocessor based development systems and assemblers.**(Book 2: 9.3, 10.1)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%): (02 Hours)

Interfacing of EPROM chip with 8085, Interfacing RAM chip with 8085**(Book 1: 6.2.2, 6.2.3)** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-IV (10 Hours)

University Portion (80%) (08 Hours)

1. 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)**

College/Institute Portion (20%): (02 Hours)

Close loop control of stepper motor and servo motor.RTC interfacing using I^2C bus

(Book 1: 12.7, 12.9, 12.13) Or related advanced topics as decided by the concerned faculty teaching the subject.

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",*

Reference:

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*

8051 Microcontroller

1. *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

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*

PEL5I103 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.

PEL5J001 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)

College/Institute Portion (20%):(2 hours)

Classification of energy Sources, Extra-terrestrial and terrestrial Radiation, Azimuth angle, Zenith angle, Hour angle, Irradiance, Solar constant Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%):(2 hours)

Velocity at different heights, Basics of Fluid Mechanics **(Textbook-1, Chapter-7.1, 7.2, 7.5)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%):(2 hours)

Urban Waste to Energy Conversion, Fuel cell. (**Textbook-1, Chapter-8.6)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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)

College/Institute Portion (20%):(2 hours)

Small hydro Resources, Magnetohydrodynamics power conversion (**Textbook-1, Chapter-11.4,12.2)** Or related advanced topics as decided by the concerned faculty teaching the subject.

Text Books:

1. *B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009*
2. *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*

PEL5J002 ADVANCED ELECTRONIC CIRCUITS (3-0-0)

MODULE-I (9 Hours)

1: Active Filters :Active Filters, Frequency response of Major Active filters, First order low-pass Butterworth filter: Filter Design, Frequency Scaling, Second-order low-pass Butterworth filter: First-order high-pass Butterworth filter, Second-order high-pass Butterworth filter, Band-pass filters: Wide band-pass Filter, Narrow Band-Pass Filter, Band-reject filters: Wide Band-Reject Filter, Narrow Band-Reject Filter, All-Pass filter.

2: Oscillators: Oscillators: Oscillator Principles, Oscillator Types, Quadrature Oscillator, Sawtooth wave generator, Voltage-controlled oscillator.

3: Comparators: Comparators: basic comparator, zero-crossing detector, Schmitt trigger, comparator characteristics, limitations of Op-Amp as comparators, voltage limiters.

MODULE-II (9 Hours)

4: Bistable Multivibrator: Bistable Multivibrator, fixed-bias bistable multivibrator, Loading, self-biased transistor binary, commutating capacitors, Triggering the binary, Unsymmetrical Triggering of the bistable multivibrator, Triggering Unsymmetrically through a Unilateral Device, Symmetrical Triggering, Triggering of a Bistable Multi Symmetrically without the Use of Auxiliary Diodes, Schmitt Trigger Circuit (Emittercoupled Bistable Multivibrator).

5: Monostable and Astable Multivibrator: Monostable Multivibrator, Gate Width of a Collector-Coupled Monostable Multivibrator, Waveforms of the Collector-Coupled Monostable Multivibrator, Emitter-Coupled Monostable Multivibrator, Triggering of the Monostable Multivibrator. Astable Collector-Coupled Multivibrator, Emitter-coupled Astable multivibrator.

MODULE-III (9 Hours)

6: Wideband amplifiers: Wideband amplifiers: The Hybrid-π , High-frequency, Smallsignal, Common-emitter Model, RC-Coupled Amplifier, Frequency Response of a Transistor Stage-The Short-Circuit Current Gain, Current Gain with Resistive Load, Transistor Amplifier Response taking Source Impedance into Account, Transient Response of a Transistor Stage, Cascaded CE Transistor Stages, Rise-time Response of Cascaded Stages, Shunt Compensation of a Transistor Stage in a Cascade, Rise Time of Cascaded Compensated Stages, Low frequency Compensation.

7: Negative Resistance Switching Devices: Voltage Controllable Negative resistance devices, Tunnel Diode operation and characteristics, Monostable Astable, Bistable circuits using tunnel diode, Voltage controlled Negative Resistance Switching Circuits.

MODULE-IV (9 Hours)

8: Voltage and Current Time Base Generators: Time-Base Generators, General features of a Time-base signal, Methods of generating a voltage time-base waveform, Exponential sweep circuit, Miller and bootstrap time base generators-Basic principles, Transistor miller time base generator, Transistor bootstrap time base generator, Current Time-Base Generators, A Simple Current sweep, Linearity Correction through adjustment of driving waveform, Transistor current time base generator.

9: Specialized IC Applications: IC 555 Timer: IC 555 Timer as a Monostable Multivibrator and its applications, IC 555 Timer as Astable Multivibrator and its applications. Phase Locked Loop: Operating principle of PLL, Phase detectors, Exclusive-OR phase detector, Monolithic phase detector, Instrumentation Amplifier and its applications.

Text Books:

1. Pulse, Digital and switching Waveforms, Second Edition - Jacob Millman, Herbert Taub and Mothiki S Prakash Rao (TMH Publication). (Selected portion from Chapter 3, 8, 9, 10, 11, 12 and 13)
2. OP-Amps and Linear Integrated Circuits- Ramakant A. Gayakwad (PHI Publication). (Selected portion from Chapter 7, 8 and 9)

3. Pulse & Digital Circuits by K.Venkata Rao, K Rama Sudha & G Manmadha Rao, Pearson Education, 2010. (Selected portions)

Reference Books:

1. OP-Amps and Linear Integrated Circuits - Robert F. Coughlin, Frederick F. Driscoll (Pearson Education Publication).
2. Pulse and Digital Circuits by A. Anand Kumar, PHI.

PEL5H001 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.

<u>Additional Module</u> (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.

PEL5D001 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.

PEL5D002 ANTENNAS & WAVE PROPAGATION

MODULE- I

Electromagnetic radiation and antenna fundamentals- Review of electromagnetic theory: Vector potential, Solution of wave equation, retarded case, Hertizian dipole. Antenna characteristics: Radiation pattern, Beam solid angle, Directivity, Gain, Input impedance, Polarization, Bandwidth, Reciprocity, Equivalence of Radiation patterns, Equivalence of Impedances, Effective aperture, Vector effective length, Antenna temperature.

MODULE-II

Wire antennas- Short dipole, Radiation resistance and Directivity, Half wave Dipole, Monopole, Small loop antennas. Antenna Arrays: Linear Array and Pattern Multiplication, Two-element Array, Uniform Array, Polynomial representation, Array with non-uniform Excitation-Binomial Array

MODULE- III

Aperture Antennas- Magnetic Current and its fields, Uniqueness theorem, Field equivalence principle, Duality principle, Method of Images, Pattern properties, Slot antenna, Horn Antenna, Pyramidal Horn Antenna, Reflector Antenna-Flat reflector, Corner Reflector, Common curved reflector shapes, Lens Antenna

MODULE- IV

Special Antennas-Long wire, V and Rhombic Antenna, Yagi-Uda Antenna, Turnstile Antenna, Helical Antenna- Axial mode helix, Normal mode helix, Biconical Antenna, Log periodic Dipole Array, Spiral Antenna, Microstrip Patch Antennas.

Antenna Measurements- Radiation Pattern measurement, Gain and Directivity Measurements, Anechoic Chamber measurement.

ADDITIONAL MODULE (TERMINAL EXAMINATION-INTERNAL)

Radio wave propagation- Calculation of Great Circle Distance between any two points on earth, Ground Wave Propagation, Free-space Propagation, Ground Reflection, Surface waves, Diffraction, Wave propagation in complex Environments, Tropospheric Propagation, Tropospheric Scatter. Ionospheric propagation: Structure of ionosphere, Sky waves, skip distance, Virtual height, Critical frequency, MUF, Electrical properties of ionosphere, Effects of earth's magnetic fields, Faraday rotation, Whistlers.

TEXT BOOKS

1. **Electromagnetic Waves and Radiating Systems**, E. C. Jordan and K. G. Balmain Pearson Education Publications,1968
2. **Antennas and Wave Propagation**, A.R.Harish, M. Sachidanada, Oxford University Press,2007
3. **Antenna Theory Analysis and Design,** C. A. Ballanis, John Wiley Publications, Second Edition,2005

REFERENCES BOOKS

1. **Antennas for all Applications**,J.D.Kraus, Ronald J Marhefka and Ahmad S Khan, Tata McGraw-Hill Book Company. Third Edition,2008
2. **Antenna Wave Propagation**, G.S.N.Raju, Pearson Education,2006
3. **Antenna and Radio Wave Propagation**, R. E. Collin, McGraw Hill Publications,1985.
4. **Antenna Analysis and Design**,W.L Stutzman and G.A. Thiele, John WileyPublications,2012.

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

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	Communication Engineering	3-0	3	100	50	2	1	50
PC	Power System Operation & Control	3-0	3	100	50	2	1	50
PE	Robotics & Robot Applications/Optoelectronics Devices & Instrumentation/Electrical Drives	3-1	4	100	50			
PE	Industrial Automation & Control/VLSI Design/Flexible AC Transmission systems/Advanced Communication Systems	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	Utilization of Electrical Energy/ Digital communication Technology/ Radar & TV Engineering/ Special Electromechanical Devices	4	4	100	50			
Minor	Electrical Machines-II							

Semester : 6th

1.	PEL6D001	Honours(O3)	Special Electro-Mechanical in Devices	4-0-0	4
2.	PEL6D002	Honours(O3)	Digital Communication Technology	4-0-0	4
3.	PEL6D003	Honours(O3)	Radar & TV Engineering	4-0-0	4
4.	PEL6D004	Honours(O3)	Utilization of Electrical Energy	4-0-0	4
5.	PEL6E101	HS(CP)	Business Communication & Skill for Interview	1-0-2	3
6.	PEL6G001	Minor(CP)	Electrical Machines - II	4-0-0	4
7.	PEL6H301	OE(CP)	Industrial Lecture #	0-0-1	1
8.	PEL6I101	PC(CP)	Communication Engineering	3-0-1	4
9.	PEL6I102	PC(CP)	Power System Operation & Control	3-0-1	4
10.	PEL6J001	PE(O1)	Robotics & Robot Applications	4-0-0	4
11.	PEL6J002	PE(O1)	Optoelectronics Device & Instrumentation	4-0-0	4
12.	PEL6J003	PE(O1)	Electrical Drives	4-0-0	4
13.	PEL6J004	PE(O2)	Industrial Automation & Control	4-0-0	4
14.	PEL6J005	PE(O2)	Flexible AC Transmission systems	4-0-0	4
15.	PEL6J006	PE(O2)	Advanced Communication Systems	4-0-0	4

PEL6I101 COMMUNICATION ENGINEERING

MODUE-I

INTRODUCTION: Elements of an Electrical Communication System, Communication Channels and their Characteristics, Mathematical Models for Communication Channels FREQUENCY DOMAIN ANALYSIS OF SIGNALS AND SYSTEMS: Fourier series,
Fourier Transforms, Power and Energy, Sampling and Band limited signals, Band pass signals

MODULE-II

ANALOG SIGNAL TRANSMISSION AND RECEPTION: Introduction to modulation,
Amplitude Modulation (AM), Angle Modulation, Radio and Television broadcasting

MODULE-III

PULSE MODULATION SYSTEMS: Pulse amplitude modulation, Pulse Time Modulation
PULSE CODE MODULATION: PCM system, Intersymbol interference, Eye patterns, Equalization, Companding, Time Division Multiplexing of PCM signals, Line codes, Bandwidth of PCM system, Noise in PCM systems,

MODULE-IV

Delta Modulation (DM), Limitations of DM, Adaptive Delta Modulation, Noise in Delta Modulation, Comparison between
PCM and DM, Delta or Differential PCM (DPCM), S-Ary System

Text Book:

1. John G.Proakis,M. Salehi, COMMUNICATION SYSTEMS ENGINEERING, 2nd ed. New Delhi,India: PHI Learning Private Limited, 2009.; Selected portion from Chapter 1,2 and 3 for module MODULE-I and MODULE-II of the course.
2. R.P Singh and S.D Sapre, COMMUNICATION SYSTEMS Analog & Digital, 2nd ed. New Delhi, India: Tata McGraw Hill Education Private Limited, 2009; Selected portions from Chapter 7 and 8 of the book for MODULE-III.

COMMUNICATION ENGINEERING LAB

List of Experiment

Any 10 experiment have to perform in the lab of around 40 hours.

1. Radiation pattern of Dipole, Yagi, Helical and Slot Antenna (3 hours)

2. Velocity Measurement using Doppler RADAR. (3 hours)

3. Study of different blocks of colour TV receiver such as RF amplifier, IF amplifier, sync separator, vertical oscillator, colour picture tube etc and measurement of various voltage signal waveform. (6 hours)

4. Polarization Detection of Dipole, Yagi, Helical and Slot Antenna (3 hours)

5. Measurement of Rafractive Index profile, Numerical Aperture, attenuation and bending loss/dispersion in a multimode optical fiber. (6 hours)

6. Study the laser diode and determination of its characteristics (3 hours)

7. Measurement of Gain of a fiber communication link using (a) optical fiber, (b) free space (3 hours)

8. Establishing and testing an optical Fiber Communication Link (6 hours)

9. Simulation of a pn sequence generator using MATLAB. (3 hours)

10. Simulation of direct sequence spread spectrum technique using MATLAB. (3 hours)
11. Simulation of TDM and WDM using MATLAB (3 hours)

PEL6I102 POWER SYSTEM OPERATION & CONTROL

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.)**
College/Institute Portion (20%) **(2 hours)**
Power system structure: (**Reference 1: 1.1, 1.2, 1.3,)** Power factor correction, three phase loads, delta to star transformation: (**Reference1: 2.5, 2.8, 2.9, 2.10, 2.11)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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.)**
College/Institute Portion (20%) **(2 hours)**
Load frequency control: **(Reference 1:12.3)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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.)**

College/Institute Portion (20%) (2 hours)

Tie line bias control: **(Reference 1: 12.4)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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.)**

College/Institute Portion (20%) (2 hours)

Synchronous machine,Steady state stability, Transient Stability: (**Reference 1:11.3, 11.4, 11.5)** Or related advanced topics as decided by the concerned faculty teaching the subject.

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- By T. K. Nagsarkar & 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.*
12. *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

PEL6J001 ROBOTICS & ROBOT APPLICATIONS

MODULLE I

Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.

MODULE II

Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors. Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

MODULE III

Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.

Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.

Robot Sensors: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot.

MODULE IV

Robot Actuators: Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.

Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.

Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacle avoidance.

Text Books:

1. Robotics and Control, R.K. Mittal and I.J. Nagrath, Tata McGraw Hill
2. Introduction to Robotics: Mechanics and control, John J Craig, PHI
3. Robotics Technology and Flexible Automation, S.R.Deb and S. Deb, TMH

Reference Books:

1. Introduction to Robotics, S. K. Saha, Tata McGraw Hill
2. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill
3. Robotics, Appuu Kuttan K.K., I.K. international
4. Robot Dynamics and Control, M.W.Spong and M. Vidyasagar , Wiley India.
5. Industrial Robotics Technology, programming and application, M.P.Groover, TMH.
6. Introduction to Robotics: Analysis, Systems, Applications, S.B.Niku, PHI
7. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford University Press
8. Fundamentals of Robotics: Analysis and Control, R. J. Schilling, PHI
9. Robotic Engineering: An Integrated Approach, R.D. KLAFTER, T. A. Chmielewski, and M. Negin, PHI
10. Robot Technology: Fundamentals: J. G. Keramas, Cengage Learning

PEL6J002 OPTOELECTRONICS DEVICES & 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)*

PEL6J003 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"

PEL6J004 INDUSTRIAL AUTOMATION AND CONTROL

(**Prerequisite: Control System Engineering – I**)

Module I: (12 Hours)

Process Control: Introduction: Process Definition, Feedback Control, PID Control, Multivariable Control. (Chapter 1 of Text Book 1)

PID Controller Tuning: Introduction, Zeigler-Nichols Tuning Method (Based on Ultimate Gain and Period, and Process Reaction Curve), Digital PID Controllers. (Chapter 13 of Text Book 2)

Module II: (15 Hours)

Special Control Structures: Cascade Control, Feedfroward Control, Feedfroward-Feedback Control Configuration, Ratio Control, Selective Control, Adaptive Control, Adaptive Control Configuration. (Chapter 10 and 11 of Text book 3)

Actuators: Introduction, Pneumatic Actuation, Hydraulic Actuation, Electric Actuation, Motor Actuators and Control Valves. (Chapter 8 of Text Book 1)

Module III: (10 Hours)

Industrial Automation: Programmable Logic Controllers: Introduction, Principles of operation, Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics) (Chapter 5 of Text Book 1)

Distributed Control: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS), Communication options in DCS. (Chapter 6 of Text Book 1)

Real-time Programming: Multi-tasking, Task Management, Inter-task Communication, Real-time Operating System. (Chapter 9 of Text Book 1)

Text Books:

1. *Krishna Kant, "Computer-Based Industrial Control", PHI, 2009.*
2. M. Gopal, "Digital Control and State Variable Methods" Tata McGraw Hill, 2003.
3. Surekha Bhanot, Process Control: Principles and Applications, Oxford university Press, 2010

Reference Books:

1. *Smith Carlos and Corripio, "Principles and Practice of Automatic Process Control", John Wiley & Sons, 2006.*
2. Jon Stenerson, "Industrial Automation and Process Control", Prentice Hall, 2003.
3. C. Johnson, "Process Control Instrumentation Technology", PHI, New Delhi
4. D.R. Coughnowr, "Process System analysis and Control", McGraw Hill.

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.

PEL6J005 FLEXIBLE AC TRANSMISSION SYSTEMS

MODULE-I (12 Lectures)

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 Lectures)

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 Lectures)

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.*

PEL6J006 ADVANCED COMMUNICATION SYSTEMS

MODULE – I: (10 hrs)

Data-Link Protocol and Data Communications Networks: Data-link Protocol Function, Character and bit Oriented Data Link Protocols. Asynchronous Data Link Protocols, Synchronous Data-Link Protocols, Synchronous Data –Link Control, High-Level Data Link Control, Public Switched Data Networks, CCITTX. 25, User-to-Network Interface Protocol. Integrated Services Digital Network (ISDN) (Chapter 23)

MODULE – II: (15 hrs)

Digital T-Carriers and Multiplexing :Time-Division Multiplexing (TDM); T1 Digital Carrier. North American Digital Hierarchy. Digital Carrier Line Encoding. T Carrier Systems, Digital Carrier Frame Synchronization. Bit Vrs Word Interleaving. Statistical TDM. Codecs and Combo Chips. FDM. AT & T's FDM Hierarchy. Composite Base band Signal . Formation of Master group. Wavelength Division Multiplexing (WDM) (Chapter 11)

MODULE – III: (8 hrs)

Cellular Telephone Concepts: Mobile telephone service, Cellular Telephone, Frequency Reuse, Interefernce, Cell Splitting, Sectoring, Segmentation, and dualization, Cellular System Topology, Roaming and Hand ofs, Cellular Telephone Network Components, Cellular Telephone call Processing (Chapter 19)

Data Communication and Networking: Data Communication Network Architecture, Protocols, and standards, Layered Network Architecture, Introduction to GSM, GPRS, CDMA (Chapter 20)

MODULE – IV: (7 hrs)

Satellite Communication: Introduction, Keepler's Law, Satellite Orbir\ts, geosynchronous satellites, Antenna Look Angles, Satellite Classifications, spacing and frequency allocation, Satellite Antenna Radiation patterns, Satellite System Link Models, Satellite System Parameters, Satellite System Link Equations, Link Budget (Chapter 25)

Satellite Multiple Accessing Arrangements: Introduction, FDM/FM Satellite Systems, Multiple Access Techniques, Frequency Division Multiple Access (FDMA), TDMA, CDMA, Channel Capacity, Satellite Radio NavigationEstimating Channel Requirements, Practical Demand Access Systems, Random Access, Multiple Access With On Board Processing. VSAT (Chapter 26)

Text Book:

1. Electronic Communications Systems Fundamentals through Advanced by Wayne Tomasi; Pearson.

References:

1. Satellite Communication - by Timothy Pratt; Addison Wesley.

PMG6M001 ENVIRONMENTAL SCIENCE AND ENGINEERING (3-0-0)

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 Management, 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.

PEL6D004 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.

PEL6D002 DIGITAL COMMUNICATION TECHNOLOGY (4-0-0) (HONORS PAPER)

Module – I **(12 hours)**

Sampling Theorem, Signal Reconstruction from uniform samples, Maximum Information Rate, Practical sampling analysis, Time Division Multiplexing. Digital Representation of Analog Signal - Quantization of Signals, Quantization error, PCM, Electrical representation of binary digits, PCM System, Companding, Differential PCM: Linear predicted design, Delta Modulation. Noise in delta modulation, Comparision with PCM & DM.

Module - II **(10 hours)**

Digital Modulation Technique:
Generation, Transmission, Reception, Spectrum and Geometrical Representation of BPSK, DPSK, QPSK, M-ary PSK, BFSK, M-ary FSK, and Minimum Shifting Keyin (MSK).

Module - III **(12 hours)**

Principle of Digital Data Transmission:
Digital Communication Systems – Source, Line coder, Multiplexer, Regenerative repeater; Line Coding, Pulse shaping – ISI and effect, Nyquist first criterion for zero ISI; Scrambling, Digital receiver and regenerative repeaters; Zero Forcing Equalizer. Timing extraction, Detection error, Eye Diagram.

A base band signal Receiver, Peak signal to RMS noise output voltage ratio, probability of error, optimum threshold, optimum receiver for both base band and pass band: calculation of optimum filter transfer function, optimum filter realization using Matched filter, Probability error of the matched filter, optimum filter realization using correlator.

Module - IV **(6 hours)**

Information Theory
The Concept of amount of Information, Average Information, Entropy; Information rate, source coding to increase average information per bit; Shanon-Fano coding, Huffman Coding, Shanon's Theoerm- Channel Capacity.

Text Books:
1. Taub's Principles of Communication Systems by H Taub, D L Schilling and G Saha, 4th Edition 2013, TMH Education Pvt Ltd, New Delhi.
2. Modern Digital and Analogue Communication Systems by B.P. Lathi and Z Ding, 4th Edition 2010, Oxford University Press, New Delhi.

Additional Readings:

1 Communication System: Analog & Digital by R P Singh, S D Sapre, 3rd Edition, TMH Education Pvt Ltd, New Delhi

2 Digital Communication by P Ramakrishna Rao, 1st Edition 2011, TMH Education Pvt Ltd, New Delhi.

3 Digital and Analogue Communication System, Leon W. Couch-II, 6th Edition, Pearson.

PEL6D003 RADAR & TV ENGINEERING (4-0-0) (HONOR SUBJECT)

Objective

- *To give the basic ideas & operating principles of different types of b/w as well as colour CTV and radar (both transmitter and receiver) and their uses.*
- *To create the awareness about the different standards of TV systems used in different countries and their basic principles.*

Module I

Radar system- Simple form of radar equation- Radar block diagram- radar frequencies- Prediction of range performance- minimum detectable signal- receiver noise- pulse reception- frequency and range ambiguities- antenna parameter – Doppler effect- system losses and propagation effects.

Module II

CW Radar – Simple CW radar- Intermediate frequency CW radar- FM- CW radar- FM- CW altimeter- Multiple frequency CW radar- Pulse doppler MTI radars- Delay line canceller- blind speed tracking radar- A scope and PPI display

Module III

Colour TV Essentials:

Compatibility , Colour perception, Three Colour theory, Luminance, Hue and Saturation, Dispersion and Recombination of light, Primary and secondary colours, luminance signal, Chrominance Signal, Colour picture tube, colour TV Camera, Colout TV display Tubes, colour Signal Transmission, Bandwidth for colour signal transmission, Colour TV controls. Cable TV, Block Diagram and principle of working of cable TV.

Plasma and LCD:

Introduction, liquid crystals, types of LCD's, TN, STN, TFT, Power requirements, LCD working Principle of operation of TN display, Construction of TN display, Behaviour of TN liquid crystals, Viewing angle, colour balance, colour TN display, limitations, advantages, disadvantages, applications.

Module IV

LED and DMD :

Introduction to LED Television , comparison with LCD and Plasma TV's, schematic of DMD, introduction to Digital Micro Mirror device, Diagram of DMD, principle of working, emerging applications of DMD.

ADV ANCED TOPICS IN TV. ENGINEERING :

Introduction, & working and block diagram of the Projector TV, 3D-TV, HDTV, Digital TV, Camcorders.

TELEVISION APPLICATIONS: Cable television, CCTV, picture phone & facsimile, television via satellite, Remote Control (Electronic control system), Introduction to Digital TV Technology and their merits.

Text Books

1. Gulati R.R., Modern Television Engineering ,Wiley Eastern Ltd.
2. Consumer Electronics by S. P. Bali(Pearson Education)
3. Michael Robin& Michael Poulin, Digital Television Fundamentals, Mc Graw Hill
4. Complete Satellite and Cable T.V by R.R Gulati(New Age International Publishers)
5. Bernard Grob& Charles E. Herndon,Basic Television and Video Systems,
6. Skolnik Introduction to Radar Systems,Mc Graw Hill,Kogakusha Ltd.

Reference Books

1. Dhake A.M.,Television Engineering,Tata Mc Graw Hill
2. Monochrome and Colour Television by R. R. Gulati
3. Damacher P. Digital Broadcasting ,IEE Telecommunication Series

COURSE OUTCOMES:

- Students will be familiar with blocks, applications and operation of monochrome TV, color TV.
- Students will be able to understand the specifications enlisted with various consumer products.
- The students will come to know about the current state of art of digital imaging.

PEL6D001 SPECIAL ELECTROMECHANICAL DEVICES (HONOR) (4-0-0)

MODULE- I

University Portion (80%):[12 HOURS]

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

College/Institute Portion (20%): (1 hour)

Microprocessor-Based Control of Stepper Motor and SRM **[Ch. 1.10, Ch.2.10**) Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- II

University Portion (80%): [10 HOURS]

PERMANENT MAGNET DC (PMDC) MOTOR AND BRUSHLESS PERMANENT DC (BLDC) MOTOR (9hours)

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)

College/Institute Portion (20%) (1 hours)

BLDC Square Wave Motors, **[Ch.3.2.5])** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- III

University Portion (80%): [8 HOURS]

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**

College/Institute Portion (20%): (1 hour)

Control of PMSM: Vector Control of PMSM, Self Control of PMSM, Sensor Control of PMSM, **[Ch. 4.8(4.8.1 to 4.8.3)]**) Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- IV

University Portion (80%): [10 HOURS]

LINEAR ELECTRIC MACHINES (9 hours)

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)

College/Institute Portion (20%): (1 hour)

Linear Reluctance Motor (LRM): Construction, Working and Features of LRM, Operation of LRM with AC and DC Supply **[Ch. 8.4:8.4.1 to 8.4.3]**) Or related advanced topics as decided by the concerned faculty teaching the subject.

Text Book:

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

Reference Book(s):

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

PEL6G001 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.*

Seventh Semester									
	Theory						Practical		
Code	**Course Name**		**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ week L/T**	**Credit Practical**	**Marks**
GS	Nano Science & Bio Technology		3-1	4	100	50			
PE	Control System Engg-II/Advanced Power Electronics/Digital Image Processing		3-1	4	100	50			
PE	Mobile Communication/Adaptive Signal Processing/Mechatronics/Switch Gear & Protective Devices		3-1	4	100	50			
OE	Soft Computing */ Satellite Communication Systems / Embedded Systems / Power Station Engg. & Economy / Marketing Management / Production & Operations Management/Computer Vision		3-1	4	100	50			
PC	Advance Lab-II/ Project						8	4	200
	Projects on Internet of Things						8	4	200
Total			16	16	400	200	16	8	400
Total Marks: 1000									
Total Credits: 24									
Honors		High Voltage Engineering / Biomedical Instrumentation/ Microwave Engineering/PLC &SCADA/SMART Grid	4	4	100	50			
Minor Specialization		Power Station Engineering. & Economy							

Semester : 7th

1.	PEL7C001	GS(CP)	Nano & Bioscience	4-0-0	4
2.	PEL7D001	Honours(O5)	High Voltage Engineering	4-0-0	4
3.	PEL7D002	Honours(O5)	Biomedical Instrumentation	4-0-0	4
4.	PEL7D003	Honours(O5)	SMART Grid	4-0-0	4
5.	PEL7D004	Honours(O5)	PLC and SCADA	4-0-0	4
6.	PEL7D005	Honours(O5)	Microwave Engineering	4-0-0	4
7.	PEL7G001	Minor(CP)	Power Station Engineering and Economy	4-0-0	4
8.	PEL7H001	OE(O4)	Soft Computing	4-0-0	4
9.	PEL7H002	OE(O4)	Other subjects	4-0-0	4
10.	PEL7H201	FE(CP)	Projects on Internet of Things	0-0-4	4
11.	PEL7I201	PC(O3)	Advance Lab - II	0-0-4	4
12.	PEL7I202	PC(O3)	Project	0-0-4	4
13.	PEL7J001	PE(O1)	Control System Engineering - II	4-0-0	4
14.	PEL7J002	PE(O1)	Advanced Power Electronics	4-0-0	4
15.	PEL7J003	PE(O1)	Digital Image Processing	4-0-0	4
16.	PEL7J004	PE(O2)	Mobile Communication	4-0-0	4
17.	PEL7J005	PE(O2)	Adaptive Signal Processing	4-0-0	4
18.	PEL7J006	PE(O2)	Mechatronics	4-0-0	4
19.	PEL7J007	PE(O2)	Switch Gear & Protective Devices	4-0-0	4

PEL7J002 ADVANCED POWER ELECTRONICS

MODULE- I [10 Hrs]

University Portion(80%): (8 Hrs)

1. **Switched Mode Power Supply:**

Isolated switched mode power supplies, Forward converter, Fly back converter, Half bridge converter, Full bridge converter, Push pull converter, Switched mode power supply with multiple outputs.

Text Book- 1- Ch- [14.2.1,14.2.2,14.2.3,14.2.4,14.2.5,14.2.6]

2. **Resonant Converters:**

Series Resonant Converters, Parallel Resonant Converters.

Text Book- 1- Ch- [8.2,8.4]

College/Institute Portion(20%): (2 Hrs)

Zero current switching, Zero voltage switching. [**Text Book-1- Ch-[8.8,8.9].** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- II

[10 Hrs]

University Portion(80%): (8 Hrs)

3. **Regulators:**

Boost regulator, Buck-boost regulator, Multi output Boost Converter, Diode rectifier fed boost converter, State space analysis of regulators.

Text Book- 1- Ch-[5.8.2,5.8.3,5.10,5.11,5.13]

4. **SMPS Control:**

Control requirements and technique, PWM controller, Isolation in the feed back loop, Power supplies with multiple output.

Text Book- 1- Ch- [14.3,14.5]

College/Institute Portion(20%): (2 Hrs)

Buck regulator, Cuk regulator. . **Text Book- 1- Ch-[5.8.1,5.8.4].** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- III

[10 Hrs]

University Portion(80%): (8 Hrs)

5. **Inverters:**

Voltage Fed Converters:

Pulse width modulation techniques, Sinusoidal PWM, Selected harmonic elimination PWM, Space vector PWM, Hysteresis band current control PWM, Sigma delta modulation. Three level inverters, Resonant inverters, Soft switched inverters

6. **Current Fed Converters:**

Load commuted inverters, Forced commutated inverters, Inverters with self commutated devices.

Text Book-3- Ch-[5.5, 5.6,5.7,5.8,5.9,6.3,6.4,6.7,6.7.2.2,6.8]

College/Institute Portion(20%): (2 Hrs)

Applications of these converters. Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE- IV

[10 Hrs]

University Portion(80%): (8 Hrs)

7. **AC voltage controllers:** AC voltage controllers with PWM Control, Matrix Converter.
8. **Application:** High Voltage DC Transmission, Interconnection of renewable energy sources and energy storage system to the utility grid, Active harmonic filter.

Book-1- Ch- 11.10,11.11

Book-2- Ch- 11.4, 17.2, 17.4

College/Institute Portion(20%): (2 Hrs)

Related advanced topics as decided by the concerned faculty teaching the subject.

Text Books:

1) *Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, Pearson.*
2) *Power Electronics: Converters , Applications and Design by Mohan, Undeland and Robbin, Wiley India Edition.*
3) *Modern Power Electronics and AC Drives by Bimal K Bose, Eastern Economy Edition, PHI.*

Reference Books:

1) *Switched Mode Power Supplies: Design and Construction by H W Whittington, B.W Flynn and D E Macpherson, 2nd Edition, Universities Press)*

PEL7J007 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 Z_f, 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]**

College/Institute Portion (20%) **[2 Hours]**

Fault limiting Reactors and Fuses: Use of Reactors, Construction of Reactors, Types of Reactors, Methods of locating Reactors, Fuse element material, types of fuses, High voltage H.R,C. Fuses and its application, Selection of fuses, Advantages and Disadvantages of Fuse.

[Ref. Book 2: CH 2.1, 2.2, 2.3, 2.4, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7] Or related advanced topics as decided by the concerned faculty teaching the subject.

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]

College/Institute Portion (20%) **[2 Hours]**

Power System Grounding: Ungrounded system, Grounded neutral system, Choice of the method of neutral grounding, Grounding Practice, Equipment Grounding (Earthing), Grounding at substations, Grounding of **[Ref. Book 2: CH 7.2, 7.5, 7.6, 7.7, 7.8, 7.9]** Or related advanced topics as decided by the concerned faculty teaching the subject.

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]**

College/Institute Portion (20%) [2 Hours]

Protection of Transmission Lines: (Over current and Carrier-aided Protection)

Over current Relay, Application of Definite Time OC Relay and IDMT Relay for protection of a distribution feeder, protection of a three phase feeder, Directional Over current Relay, Need for Carrier-aided Protection, Various options for a Carrier, Coupling and Trapping the carrier into the desired line section, Unit type Carrier-aided Directional comparison Relaying, Carrier-aided Distance schemes for Acceleration of Zone II, Phase comparison Relaying.**[Text Book 2 : CH 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6]** Or related advanced topics as decided by the concerned faculty teaching the subject.

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, SF_6 , 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]**

College/Institute Portion (20%) [2 Hours]

Protection against Over voltage due to lightning: Mechanism of Lightning, Lightning stroke, Over voltage due to lightning, Protection against lightning, Different types of Arrester, Arrester Ratings, Arrester locations and effect of cables, Surge Absorber.**[Ref. Book 2: CH12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Text Books:

1. *Power System Protection and Switchgear – B.Ravindranath & M.Chander–New Age International Publishers (Second Edition).*
2. *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.*

PEL7G001 POWER STATION ENGINEERING & ECONOMY

Module-I: [10 Hours]

University Portion (80%):

1. Introduction (1 hour) Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario. **(Nag-1.5)**

2. 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)**

3. 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)**

College/Institute Portion (20%): (2 hours)

Tariff or Charge to Consumer, Specific Economic Energy Problems **(Deshpande-2.9, Vopat-33.1, 33.2, 33.3, 33.4, 33.5)** or related advanced topics as decided by the concerned faculty teaching the subject.

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)**

College/Institute Portion (20%): (2 hours)

Different types of generators and Exciters, earthing of a power system **(Deshpande-10.2, 10.3)** or related advanced topics as decided by the concerned faculty teaching the subject.

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)**
College/Institute Portion (20%): (2 hours)
Types of Hydroelectric Plant and their fields of use, characteristics of generators, Power station control **(Deshpande-7.8, 8.8, 8.9)**or related advanced topics as decided by the concerned faculty teaching the subject.

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)**
College/Institute Portion (20%): (2 hours)
Brief idea about national grid and its operational problems or related advanced topics as decided by the concerned faculty teaching the subject.

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:

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.*

PEL7D001 HIGH VOLTAGE ENGINEERING

Module-1 **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]**
College/Institute Portion (20%): **1 hour**
Tripping and control of impulse generators [**Text Book 1**:**6.5**] Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-2 **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]**
College/Institute Portion (20%): **2 hours**
Post-Breakdown Phenomenon and Application, Testing of transformer oil [**Text Book 1:2.13, 3.5]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-3 **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]**
College/Institute Portion (20%): **2 hours**
Digital technique in high voltage measurement. .Cathode-Ray Oscillographs for Impulse Voltage and current Measurement [**Text Book 1:7.4]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module-4 **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]**
College/Institute Portion (20%): **1 hour**
Radio Interference Measurement, Testing HVDC valves and equipment [**Text Book 1:10.6, 10.7]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Text Book

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

Reference Book

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

ADVANCE ELECTRICAL COMPUTATION LAB-II

List of Experiment:

1. Provide experimental practice in AC circuit power analysis and design for maximum power transfer design.
2. Transient analysis of first & second order circuits
3. Modeling, simulation and analysis of coupled circuit's analysis
4. Study of the effect of Q on frequency response and bandwidth of series and parallel resonant circuits.
5. Study of low pass and high pass filters.
6. Circuit designs of ADC and DAC
7. Determination of self and mutual inductance of a coupled circuit
8. Power flow solution using Newton-Raphson Method.
9. Fast Decoupled Load Flow.