EE 842: ELECTRIC POWER SYSTEM –IV (3-1-0)

Full marks: Theory—100
Sessional=75

1. **Thermal Power Plant:**

   Thermal power plant – economical, and ecological. Line diagram of thermal power plant- Boiler: classifications and operational issues, Super heater, Reheaters, Economizer, air heater, draft system, feed water heater, and evaporator, cooling water supply and cooling tower. Speed governor, station auxiliaries, Ash handling system for thermal power plant. Emission issue of thermal power plant.

2. **Hydro power plant:**

   Classification of hydro power plant, economical and ecological issues related to the selection of site of hydro power plant , Estimation of generation capacity of hydro power plant, Selection of turbine, plant layout, governor and hydro plant auxiliaries.

3. **Nuclear power plant:**

   Fundamental of nuclear fission, schematic of nuclear power plant, nuclear fuels and fertile materials, nuclear reactor, chain reaction, moderator, coolants, control of fission, reactor operation, types of reactors , economical, and ecological issues of nuclear power plant .

4. **Renewable Energy resources and power plants**

   Solar PV power plant, principle and operation, stand alone Solar PV power plant, Grid Connected Solar PV power plant, and operation issues of solar inverters.

   Wind power plant, wind turbines, wind generator- doubly fed induction generator for wind power plant- its operational issues.

5. **Economic Operation Of Thermal plants**:

   Methods of loading turbo-generators, input-output curves, heat ratio and incremental cost, co-ordination equation, economic loading of units, with and without transmission loss, penalty factor, iterative methods of solving co-ordination equation, economic thermal dispatching with network losses considered, B-matrix loss formula and its derivatives, economic dispatch versus unit commitment(UC), constraints in UC, UC solution method, generation Scheduling, , introduction to load forecasting.

6. **Hydrothermal co-ordination:**

   Advantages of combined operation , base load and peak load consideration , combined operation of run-off river and thermal plants , hydro electric plant models, scheduling problems, short-term hydro-thermal scheduling, long-term aspects of hydro and thermal plants, co-ordination equations in hydro-thermal operations, use of dynamic programming in hydro-thermal scheduling.

BOOKS

1. Wood and Wollenburg: Power generation, operation and control—John Wiley and sons.
2. Electrical Power—S.L.Uppal.
3. Power system operation and Control – P S Murty Tata McGRAW-Hill
4. Electric Energy System Theory: An Introduction- Olle L. Elgerd Tata McGRAW-Hill

EE 843: High Voltage Engineering (Elective)

L	T	P
3	1	0

Theory Marks: 100
Sessional Marks: 75

1. **Conduction and Breakdown in Gases**:

Desirable properties of gas and insulating medium, Townsond's current growth equations, Townsond's criterion for breakdown, Electronegative gases and their breakdown, Streamer theory, Baschen' s law.

2. **Conduction and Breakdown of liquid Dielectrics**:

Pure and commercial liquids, origin and purification, breakdown of commercial liquids, Transformer oil- composition, properties and deterioration: Inhibitor.

3. **Breakdown of solid Dielectrics**:

Different types of breakdown, measurement of intrinsic strength, partial discharge.

4. **Electrical Properties of High Vacuum**:

High Vacuum as dielectric, breakdown conduction, factors affecting breakdown voltage, breakdown phenomenon.

5. **Lighting Over-voltage**:

Measuring instruments, Magnetic surge crest ammeter, Kyldonograph, Fulchronograph, Oscillograph, Protective devices, surge absorbers, ground and counterpoise wires, lighting arresters, switching over voltages- origin, wave shape and magnitudes, protective devices.

6. **High-voltage Generation**:

Alternating voltage: transformers in cascade, single units, high frequency transformers, direct voltage: Voltage multipliers and cascade circuits using rectifiers, electrostatic machines, voltage stabilization, transient voltage, impulse generator, analysis of the basic circuits, standard impulse wave-shape, multi-stage circuits, wave shape control, triggering, general construction, synchronization with oscilloscope.

7. **High-voltage Measurement**:

Measurement of high direct, alternating (rms and peak) and impulse voltage and currents. Uniform field electrodes, measurement of dielectric constant and loss factor, Schering bridge, Wagner earth discharge and measurement.

8. **High-voltage Testing**:

Low-frequency tests, impulse tests, test circuits, control gear, testing of overhead line insulators, cables and transformer oil.

9. **High-voltage Equipment**:

Bushings: classification, construction and application, Grading, Breakdown of bushings, design and constructional features of high-voltage resistors, High-voltage capacitors, guard rings and shields.

10. **High-voltage Laboratory**:

Planning, testing and other facilities, test equipment, clearance and layout safety measures, grounding, High-voltage connections.

References:

1. Kuffel E. and Abdulla , M., 'High Voltage Engineering', Paragon Press, London.
2. Naidu, M. S., and Karmaju, V., 'High Voltage Engineering', Tata Mc Grow Hill.
3. Chourasia, M. P., 'High Voltage Engineering', Khanna publishers.
4. Alsten, 'High Voltage Engineering'.
5. Jha, R., A. S., 'High Voltage Engineering', Dhanpat Rai & Sons.
6. Rind , D. 'High Voltage Laboratory Technics, PHI.

L T P
(3 1 0)

EE 841: INDUSTRIAL DRIVES AND CONTROL

Full marks: Theory = 100
Sessional=75

1. **Dynamics of Electric drives:**

Classification of electric drives, types of load, speed-torque characteristics of loads and motors, selection of motors, dynamics of motor- load combination, four-quadrant operation, moment of inertia, steady state and transient stabilities of electric drives.

2. **Characteristics of motors**:

Review of the speed-torque characteristics of the important AC and DC drive motors. Transfer function modeling of DC motor.

3. **Starting:**

Effect of starting on power supply, motor and load, starting methods, automatic starting circuits- time and current limit acceleration, energy relations and reduction of energy loss during starting.

4. **Electric braking**:

Braking methods, speed-torque characteristic under braking conditions, energy relations and reduction of energy loss during braking.

5. **Rating of motors:**

Heating: Heating and cooling of motors, loading condition and classes of duty, power rating and selection of motors for different applications, load inertia and load equalization.

6. **Mechanical Features for Electrical Motors:**

Types of enclosures, bearings, mountings and transmission of drive, reduction of noise.

7. **Thyristorised DC motor Drives:**

Speed equations and performance characteristics of DC motors, single phase and three phase controlled converter drives, dual converter schemes, two/four quadrant chopper drives, regenerating braking with DC series motor fed from a chopper, closed loop control.

8. **Thyrisorised AC motor drives:**

Speed equations and performance characteristics of three phase induction motors, induction motor drives using thyristors for static voltage control, slip-power recovery and rotor resistance control, variable frequency operation of three-phase induction motors with constant flux and torque. Inverter/cycloconverter control of induction and synchronous motors, closed- loop control.

9. . **Industrial application of electric motors**:

Important processes, requirements of drives and types of motors used in rolling mills, pulp and paper mills, cement mills, sugar mills, and coal mining, machine tool drives.

Books/References:

1. Pillai, S.K.: Afirst Course in Electric Drives- Wiley Eastern
2. Partab,h.: Art and science of utilization of electric energy-Dhanpat Rai & Sons.
3. Chilkin, M.: Electric drives—Mir publishers, Moscow.
4. Rashid ,M.H.: Electronics-Prentice hall of India.
5. Subramanium,V.: Thyristor control of Electric motors-TMH
6. Vicker, H.: Induction motor-McGraw Hill.

EE 844.1: Advance Topics in Power system (Elective-I)

L	T	P
3	1	0

Theory Marks: 100
Sessional Marks: 75

1. Power system optimization:

Optimal load flow solution- The Lagrangian Function, method for Dommel and Tinney, Elgerd method, El-Abiad and James method, Kirchmayer method for Hydo-thermal co-ordination and Dynamic programming for Hydo-thermal co-ordination.

2. **Contingency analysis of power system** :

Importance of contingency analysis of a power system, Contingency analysis for line outage, Generation outage and loss of generation of an inter connected power system. Corrective measure for a selected contingency situation.

3. **Power system state estimation**:

Role of estimator of a power system measurements, Method of least squares for state estimation, WLSE state estimation, Composition of the Jacobian Matrix and measurement variables for state estimation of a power system.

4. **Introduction to FACTS**:

Brief introduction to FACTS devices- STATCOM, SVS, UPFC, etc. Their basic representation and operating principle. Role of FACT devices in real and reactive power control.

5. **Harmonics in Power System**:

Different sources of harmonics, affects of harmonics on power system performance and power quality.

6. Computer aided operating and control of power system

Power system load dispatch issues- unit commitment (day ahead scheduling), on line operating constraints for zones etc (Availability based tariff concept and realization.). Application of SCADA in power system, concept of smart grid.

Restructuring of power system, Issues of de-regulation and open access of power system planning and operation.

References:

1. Power System Analysis – T K Nagsarkar and M S Sukhija OXFORD University.
2. Power system operation and Control – P S Murty Tata McGRAW-Hill
3. Electric Energy System Theory: An Introduction- Olle L. Elgerd Tata McGRAW-Hill
4. On line material form various sources

EE /PG 242 Power Quality Analysis and Assessment (Elective-II)

L T P
(3 – 1 – 0)
Theory Marks =100
Sessional Marks = 75

1. **Introduction**: Power quality and its importance, transients, long duration voltage variations, short durations, voltage variations, waveform distortions, voltage fluctuations, power frequency variations.

2. **Voltage Sags and interruptions**: Sources of sags and interruptions, Estimating voltage sag performance, mitigation of voltage sags: active series compensators, Static transfer switches and fast transfer switches, solution at the end user level and their economic implications.

3. **Transients Overvoltage**: Source of transients overvoltage, principles of overvoltage protection, devices for overvoltage protection

4. **Harmonics**: Harmonic distortions, sources of harmonics and their locations, effects of harmonics Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters. IEEE standards.

5. **Long duration voltage variations**: principles of regulating the voltage, devices for voltage regulation

6. **Power quality benchmarking**: Benchmarking processes, RMS voltage variation indices, harmonic indices, Power Quality State Estimator (PQSE)

7. **Power Quality Monitoring:** Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer – Quality measurement, equipment - harmonic / spectrum analyzer - flicker meters - disturbance analyzer, Applications of expert systems for power quality monitoring

TEXT BOOK:

1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill,2003.(For Chapters1,2,3, 4 and 5)

EE 844.2: RELIABILITY ENGINEERING (Elective-I)

L	T	P
3	1	0

Theory Marks: 100
Sessional Marks: 75

1. **Introduction to Reliability Engineering**: Definition of reliability, reasons for reliability engineering programmes, applications and benefits, reliability and cost, reliability and quality, definition of availability and maintainability.

2. **Reliability Mathematics**: Basic probability theorems, rules for combining probabilities-independent events, mutually exclusive events, complementary events, conditional events, simultaneous occurrence of events; Random variables-discrete and continuous, their properties; Data reduction to frequency histograms and polygons, frequency distribution and probability density function, failure probability density function and its estimate, cumulative frequency and cumulative distribution, data and distribution descriptive values-central tendencies (mean, mode and median), distribution moments, variance and standard deviation, coefficient of variation, skewness, kurtosis, fractiles, percentiles and quantiles, distribution parameters-location, shape and scale parameters; Standard distributions-discrete and continuous, discrete-Binomial and Poisson distributions, continuous-exponential, normal, log-normal, Rayleigh, Weibull, Gamma and extreme-value distribution.

3. **Concepts of Reliability**: Definition of reliability; Failure- causes of failures, modes of failures, life characteristics pattern (Bath-tub curve); Measures of reliability-failure rate, mean time between failure (MTBF), mean time to failure (MTTF), derivation of reliability function and its properties, relationship between density function, distribution function, reliability and failure rate; Hazard rate function-constant hazard model, linear hazard model; Reliability evaluation at component level; Probability plotting.

4. **System Reliability Evaluation**: Reliability block diagram; Systems-series, parallel, series-parallel, parallel-series, k-out-of-m system, standby system; Complex system- decomposition technique, tie set and cut set method, Boolean truth table method; Fault tree and Event tree method; Redundancy technique in system design-component versus unit redundancy, weakest link technique, mixed redundancy, standby redundancy.

5. **Availability Analysis**: Markov process and general concept of modeling; Instantaneous and Steady-state availabilities; State-space diagram; Markov model for-two repairable components, three repairable components, standby redundant system, non-repairable system; Stochastic transitional probability matrix; Steady-state availability calculation of systems.

6. **Maintained Systems**: Maintenance, objectives of maintenance, forms of maintenance, types of maintenance; Preventive maintenance-idealized maintenance, effect of preventive maintenance on reliability; Corrective maintenance; Definition and derivation of Maintainability function.

7. **Economics of Reliability Engineering**: Economic issues, manufacturer's cost, customer's cost, reliability achievement cost models, reliability utility cost models, depreciation-cost models; availability-cost model for parallel systems.

References:

1. Reliability Engineering - E. Balagurusamy, Tata McGraw Hill Publishing Comp. Ltd., 1984.
2. Reliability Engineering – A. K. Govil, Tata McGraw Hill Publishing Comp. Ltd., 1983.
3. Introduction to Reliability Engineering- E. E. Lewis, John Wiley and Sons, 1996.
4. Reliability Engineering Handbook (Vol 1) – Dimitri Kececioglu, Prentice Hall PTR, 1991.
5. Reliability Evaluation of Engineering Systems-concepts and techniques-Roy Billinton and Ronald N. Allan (2^{nd} Edition), Plenum Press, 1992.
6. Probabilistic Reliability- an engineering approach- M. L. Shooman, McGraw Hill Book Company, 1968.

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EE 845.3 ADVANCED COMMUNICATION SYSTEMS (elective-II)

L T P
(3 – 1 – 0)
Theory Marks =100
Sessional = 75

Propagation impairments at microwave and millimeter wave bands-Attenuation, depolarization ,scintillation, frequency management, System planning, Link budget, Link design for LOS and earth space paths.

Micro strip patch antennas-basic configuration and advantages, radiation mechanism, basic characteristics and feeding techniques, broadbanding techniques, microstrip arrays, Active integrated antennas-active devices and passive elements.

Optical communication IM/DD, S/N ratio and BER,Power penalty, WDM- System requirements, MUX/DEMUX Devices, Fiber optic subscribe loop, coherent optical communication, optical amplifiers, fiber nonlinearities,soliton propagation, photonic switching.

Guided and unguided propagation, optical transmitters and receivers, direct detection based systems, Receiver noise projess and statistics, digital & analog fiber optic links, free space optical links, Fiber optic LAN,Elements of coherent optical communication systems.

Books

Advanced Optical Communications Systems And Networks -- Milorad Cvijetic & Ivan B. Djordjevic -- Asian Books Pvt. Ltd.

Fiber-Optic Communication Systems Hardcover Govind P. Agrawal - Willey

EE 845.2 : Digital Image Processing (Elective)

L	T	P
3	1	0

Max Marks: 100
Sessional: 75

Human Visual System and Image perception; Monochrome and colour vision models; Image acquisition and display; Video I/O devices; Standard video formats; Image digitization; display and storage; 2D signals and systems;

Image Transforms: 2D, DFT, DCT, Harr transform;

Image enhancement: Some simple intensity transformations, Histogram processing; Image subtraction; Image averaging.

Spatial filtering: Background; Smoothing filters; Sharpening filters.

Image Restoration: Degradation Model; Inverse filtering; Least mean square (Wiener) Filter.

Image Compression: Lossy Compression; Lossless Compression.

Image Segmentation: Detection of discontinuities; Edge linking and Boundary Detection; Thresholding;

Representation and Description: Representation schemes; Boundary descriptors; Regional descriptors; Morphology.

Applications of Digital Image Processing

Books:

1) Funndamentals of Digital Image Processing, A.K.Jain, Pearson Education.
2) Digital Image Processing, R.C.Gonzalez & R.E.Woods, Perason Education.
3) Digital Image Processing with MATLAB, R.C.Gonzalez & R.E.Woods, S.L.Eddins, Pearson Education.

EE 845.1 : DIGITAL SIGNAL PROCESSING (ELECTIVE-II)

L T P
(3 – 1 – 0)
Theory Marks =100
Sessional Marks = 75

1. INTRODUCTION TO DIGITAL SIGNALS AND SYSTEMS :- Classification of Digital Signals and Digital Systems. Concept of frequency in Discrete Time Signals. Nyquist's Sampling Theorem. Creation of Discrete Time Signals by sampling. ADC & DAC. Quantization and Coding, Quantization Noise and Quantizers. Representation of Discrete Time Signals, Set Representation, Function Representation, Graph Representation, Table Representation. Representation of Discrete Time Systems, Block Diagram Representation, Representation by Difference Equation.Implementation Structures of Discrete Time Systems, Form-I and Form-II Structures.
2. PROCESSING OF DISCRETE TIME SIGNALS : - ConvolutionProcess of Discrete Time Signals. LTI System, ConvolutionSum,Properties of Convolution Function, Causality and Stability. Conditions of Time Invariance and Stability ofDiscrete Time Systems represented by Difference Equation. Correlation Function of Discrete Time Signals. Applications of Correlation Process, Autocorrelation, Cross Correlation, Input-Output Correlation. Properties of Correlation Function.
3. Z-TRANSFORM AND IT'S APPLICATION IN ANALYSIS OF DISCRETE TIME LTI SYSTEMS :- Direct z-transform, Inversez-transform, Properties of z-transform, ROC, System Function, Poles & Zeroes, Convolution using z-transform. Analysis of LTI Systems in z-Domain, Transient response and Steady State Response, Conditions of causality and Stability in z-Domain. Solution of Difference Equation in in z-Domain.
4. FREQUENCY DOMAIN ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS :- Fourier Series representation of Periodic Discrete Time Signals. Fourier Transform of Discrete Time Signals. Relationship Between Fourier Transform and z-Transform. Properties of Fourier Transform of Discrete time Signals. Frequency response of LTI Systems. Input-Output Correlation of LTI systems and Spectrum at the output. LTI Systems as Filters. Frequency Domain Sampling and DFT. Properties of DFT. Linear Filters using DFT. DCT. FFT Algorithms and Applications.
5. DIGITAL FILTERS :-IIR Systems, Structure of IIR Systems. FIR Systems, Structure of FIR Systems. Design of IIR Systems, Designing by Approximation of Derivatives, Designing by Impulse Invariance, Designing by Bilinear transformation. Design of FIR Systems, Designing by Window Method, Designing by Frequency-Sampling Method. Design of

Optimum Equiripple Linear Phase FIR Filter. Design of FIR Differentiator. Design of Hilbert Transformer.Introduction to Multi-rate Digital Signal Processing, Sampling Rate Conversion, Filter Structures, Multistage Decimator And Interpolators, Digital Filter Banks

REFFERENCE BOOKS

1. Digital Signal Processing : By : Proakis&Manolakis : Pearson.
2. Digital Signal Processing: By: Salivahanan, Vallavaraj and Gnanapriya: TMH