TEACHING SCHEDULE & STUDY SCHEME

M. TECH. PROGRAMME

(Electrical Engineering)

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR

August, 2003

DETAILED SYLLABUS AND OTHER CONDITIONS FOR THE PROPOSED COURSE
M.TECH. ELECTRICAL ENGINEERING

Schedule of Teaching

Lecture	Tutorials (per week)	Total	
4	0	4	All theory subjects
			Project
			Seminar
			Dissertation

Schedule of Examination

Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
3	100	50		150
		50	50	100
		100		100
		Satisfactory/not Satisfactory		

SEMESTER-I

ELE-501	Power System Operation and Control
ELE-502	Advanced Power System Analysis
ELE-503	Advanced Power Electronics
ELE-504	Digital Control Systems
ELE-505	Advanced Electrical Machines

SEMESTER-II

ELE-506	Power System Protection
ELE-507	Advanced Mathematics
ELE-508	HVDC Transmission
ELE-	Elective-I
ELE-	Elective-II

SEMESTER-III

ELE-	Elective-III
ELE-	Elective-IV
ELE-580	Project
ELE-590	Seminar

SEMESTER-IV

ELE-500	Dissertation

LIST OF ELECTIVES

ELECTIVE-I

ELE-509	Power System Stability
ELE-510	EHVAC Transmission
ELE-511	Optimization Techniques

ELECTIVE-II

ELE-512	Microprocessor and their Applications
ELE-513	Applied Instrumentation
ELE-514	Fast Transients in Power Systems

ELECTIVE-III

ELE-515	Energy Efficient Machines
ELE-516	Advanced Electrical Drives
ELE-517	Non Conventional Energy Systems

ELECTIVE-IV

ELE-518	Power System Reliability
ELE-519	Power System Planning
ELE-520	Power System Communication

		L: 4	Marks	Hrs.
ELE: 501	**Power System Operations and Control**	**Univ. Exam.**	**100**	**3**
		Sessional	**50**	

1. Characteristics of Power Generation Units

Characteristics of steam units, variation of steam unit characteristics,
cogeneration plants, Light Water, moderated nuclear reactor units, Hydroelectric Units, Composite generation production cost functions.

2. Economic dispatch of Thermal Units

The economic dispatch problem; Thermal dispatching with network losses considered, penalty factors, lambda-iteration method, Gradient Method, Newtons Method, Economic Dispatch with piecewise linear cost functions, Economic dispatch using dynamic programming. Base Point and participation factors. George and Kron transmission loss formula (No derivation required), limitations of loss formula exact method of calculating penalty factors from power flow, Introduction to optimal power flow. Solution of optimal power flow by gradient method.

3. **Unit Commitment**

Economic dispatch vs unit commitment, constraints in unit commitment, Unit Commitment solution by priority list method and forward dynamic approach.

4. **Hydro-Thermal Co-ordination**

Introduction to long range and short range hydro-scheduling, Types of short range scheduling problems. Scheduling energy. The short term hydro-thermal scheduling problems and its solution by Lambde-Gamma iteration method and by Dynamic programming. Hydro units in series, Pumped storage hydro-plant.

5. **Generation Control**

Generator, Prime mover, Governor, Tie line and load models. Load frequency and generation control, supplementary control action, tie line control, generator, allocation, automatic generation control (AGC) implementation.

6. **Interchanges of Power and Energy**

Economy interchange between interconnected facilities. Pooling of interconnect systems. Analysis of losses in interconnect systems. Theory of Economic operation of interconnect area.

7. Development of overall Cost of Electric Power, Economic Philosophy of Revenue requirements, Cost breakdown construction cost, Fuel Cost, O&M Cost.

8. Reserve generating capacity, reliability, availability and capacity factor, load factor, generating capacity mix.

Recommended Books:

a) Allen J. Wood and Brace F Wollenberg, Power Generation operation and control, John Willey & Sons 2nd edition 1996.
b) O.I. Elgerd, Electric Energy system Theory : - An Introduction TMH, 2nd Edition.
c) L.K. Krichmayer, Economic operation of Power Systems, John Willey & Sons, N.Y.
d) E.L. Grant, Principles of Engineering Economy, Ronald Press, N.Y. 1970.
e) Related IEEE/IEE publications.

Note:

1. ***Eight questions, well distributed out of the entire syllabus are to be set.***
2. ***Five questions are to be attempted.***

		L: 4	Marks	Hrs.
ELE: 502	**Advanced Power System Analysis**	**Univ. Exam.**	**100**	**3**
		Sessional	**50**	

1. Formation of network matrices, singular and non-singular Transformation. Algorithms for formation of bus admittance and bus impedance matrices. Sparsity Technique and optimal ordering.

2. Load flow studies using Y bus Gauses-Scidel, Neuton Raphson, Fast Decoupled Power Flow, Z-Bus formulation for load flow solution, Comparison of various methods of load flow solution.

3. Three Phase Networks, Three Phase Network Elements, Balanced Network, Transformation Matricies, Three Phase Unbalanced network Elements, Algorithm formation of Three Phase Bus Impedance Matrix, Modification of Three Phase Bus Impedance Matrix for changes in the Network.

4. Network faults and Ceontingency analysis: Facult computation using Z – Bus, Short Circuit Calculation for Three Phase Network using z-bus, Contingency analysis for power system.

5. State estimation from online measurements: The line power flow state estimation, State estimation and noisy measurements, Monitoring the Power System Determination of Varience Z2, to normalize measurements, improvement state estimates by adding measurements.

Recommended Books

1. Glonn N. Stagg and Aimed H. El-abiad, ‘ Computer Method in Power System Analysis’ McGraw Hill, International addition 1988.

2. George L. Kusic, “ Computer Aided Power System Analysis” Prentice Hall, 1986.

3. J. Arrillage, C.P. Amold and S. J. Harker, “ Computer Modeling of Electrical Power Systems” John. Willey and Sons 1983.

4. O.I. Elgard, Electric Energy Systems An Introduction, Tata McGraw Hill, 1971.

5. M.A. Pai, Computer Techniques in Power Systems Analysis Tata McGraw Hill, 1979

6. A. Bramaller, R.N. Allan, Y.M Hamam , Sparisity, Pitman Publishing 1975.

7. P.M. Anderson, Analysis of Faulted Power System, IEEE Press Book.

8. Related IEEE/IEE Publication.

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		L : 4	Marks	Hrs.
ELE : 503	**Advanced Power Electronics**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. Power Semiconductor Diodes

Diode V-I Characteristics, Reverse Recovery Characteristics, Power Diodes Types, Forward and Reverse Recovery Time, Series & Parallel Connected Diodes.

2. Thyristor

V-I Characteristics, Turn ON & Turn OFF Characteristics, Thyristor Type, di/dt and dv/dt protection, Series and Parallel Operation of Thyristor, Thyristor circuit, UJT and PUJT Thyristor connection Techniques.

3. Power Transistors

Bipolar Junction Transistors, Their steady State & Switching Characteristics, Power MOSFET'S and their steady State & Switching Characteristics, Gate derive SIT's & IGBTS's, Series & Parallel Operation di/dt and dv/dt limitations.

4. **Controlled Rectifiers**

Single Phase & Three Phase Full Converter with R-L load, Single phase & three phase dual converters, Power factor improvement technique.

5. **A.C. Voltage Controllers**

Principle of phase control, Single Phase and Three Phase Full Controllers, Cycloconvertor, A.C.Voltage Controllers with PWM Control, Effects of source & Load Inductances.

6. D.C. Choppers

Chopper Classification, Thyristor Chopper Circuits, Effect of Service and Load Chopper Circuit Design.

7. **PWM**

Inverters, Principal of Operation, Performance Parameters, Single Phase Bridge Invertors and their Voltage Control, Harmonic Reduction, Invertor Circuit Design.

Recommended Books

1. M.H.Rashid, Power Electronics, Circuits Devices and Applications, PHI, 1994.
2. P.C.Sen, Power Electronics, TMH, 1987.
3. P.S.Bhimbara, Power Electronics, Khanna Publishers, 1993.
4. Cyril, W.Lander, Power Electronics, MHI,1993.
5. M.D.Singh & K.B.Khanchandani, Power Electronics, TMH, 1998
6. Related IEEE/IEE Publication.

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		L : 4	Marks	Hrs
ELE: 504		**Univ. Exam.**	**100**	**3**
	Digital Control Systems	**Sessional**	**50**	

1. Signal Processing in Digital Control

Digital control, Configuration of the basic Digital control scheme, Principles of signal conversion, Basic Discrete-Time signals, Time-Domain Models for Discrete - Time Systems, Transfer function Model, Stability in the Z-Plane & Jury stability criterion, Sampling as impulse modulation, Sampled spectra & Aliasing, Filtering, Practical aspects of the choice of sampling rate, Principles of Discretization, The Routh stability Criterion on the r – Plane.

2. Models of Digital Control Devices & Systems

Z – Domain, Description of Sampled continuous – Time Plants, Z- Domain Description of Systems with Dead Time, Implementation of Digital Controllers, Digital temperature Control System, Digital Position Control System, Stepping motors & their control.

3. Design of Digital Control Algorithms

Z-Plane specifications of control system design, Digital Compensator Design using frequency response plots, Digital Compensator design using root locus plots, z – Plane Synthesis.

4. Control System Analysis using state Variable Methods

State Variable representation, Conversion of state Variable models to Transfer functions, Conversion of Transfer functions to Canonical state Variable models, Eigen values & Eigen Vectors, Solution of state eruations, Concepts of Controllability & Observability, Equivalence between transfer function & State Variable Representation, Multivariable systems.

5. State Variable Analysis of Digital Control Systems

State descriptions of Digitals Processors, State description of Sampled continuous – Time Plants, State description of Systems with dead Time, Solution of state differencial equations, Controllability & Observability, Multivariable Systems.

Recommended Books

a) Raven, F.H., Automatic Control Engg. , McGraw Hill Book Company.

b) Shinners, S.M. Modern Control System Theory & Design, John Wiley & Sons.

c) KUO, B.C., Automatic Control System, Prentice Hall.

d) Ogata, K., Modern Control Engineering, Prentice Hall.

e) Nagrath, I.J., & M. Gopal, Control Systems Engg. John Wiley & Sons.

f) Truxal, J.G. , Automatic Feedbach Control system Synthesis, Mc-Graw Hill Bok Company.

g) Ogata, K., Dicrete Time Control Systems, Prentice Hall.

h) Related IEEE/IEE Publication.

NOTE:

1. **Eight questions, well distributed out of the entire syllabus, are to be set.**
2. **Five questions are to be attempted.**

		L : 4	Marks	Hrs.
ELE : 505	**Advanced Electrical Machines**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. Polyphase Synchronous Machines :-

a. **M**athematical : Basic Synchronus machine parameters, Voltage, Flux linkage and inductance relations, Park's transformation – its physical concept, equations of performance.

b. **B**alanced Steady State Analysis : Phasor equations and phasor diagrams, Power-angle characteristics, Cylindrical rotor and Salient pole machines, Short circuit ratio.

c. **T**ransient Analysis : Three phase short circuits, Armature and field transients, Transient trque, Sudden reactive loading and Unloading. Transient Analysis - a qualitative approach, Reactances and Time – Constants from equivalent circuits, Measurement of Reactances, Transient Power – angle characteristics.

d. **S**ynchronous – machine Dynamics : The basic electromechanical equation, Linearized Analysis, Large Angular/oscillation, Non-linear analysis.

2. Transformers :-

a. Multi-Circuit Transformers : General theory, Equivalent circuits, Three winding transformer as a multi-circuit transformers, Determination of parameters.

b. Excitation phenomena in Transformers : Hamonics in Single – phase transformers, Harmonics in three-phase transformers, Disadvantages of harmonics, Suppression of harmonics.

c. Transformer Transients : Inrush current phenomena, Qualitative approach, Analytical approach, Inrush current in 3-phase transformers.

d. Unbalanced Operation of three-phase Transformers : Single phase load on three-phase transformers, Single – Phasing in 3-phase transformers, Effect of using tertiary winding.

Recommended Text Book

Generalized theory of Electrical Machines by Dr. P.S. Bimbhra (Khanna Publishers.)

Reference Books : -

1. Generalized theory of electrical Machines by B. Edikins.
2. Synchronous machines by Concordia.
3. Power System Stability Vol. III by E.W. Kimbark.
4. Electrical Machinery by Fitzegerald; Kingsley.
5. Electrical Machines by A. Draper.
6. Magnetic Circuits and Transformer MIT Staff.
7. T. and D. reference Book (Westing house reference book.)
8. Electromagnetic transients by Adkins and Hoffman.
9. Related IEEE/IEE Publications.

Note :

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		L : 4	Marks	Hrs.
ELE : 506	**Power System Protection**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

Fundamentals of relaying, types of relays, their classifications and theory Phase and amplitude comparators. Static Comparators, Computer Applicatiopns to protective relaying.

Transmission Line Protection, Carrier Current Protection. Applications of microwave Channels for protective relaying, Selection of suitable static relaying, scheme for transmission line protection. Performance specifications of distance relays effect of fault resistance and effects of power swings on operation of relays. Distance relay settings. Requirement of Characteristic for different zeros. Selection of suitable static relaying schemes for transmission lines.

Generators and Transformers Protection, CT's and PTs burden and accuracy and their connections. Protection of rotor winding, miscellaneous protection schemes for generators and transformers, Overfluxing protection of transformers.

Differential Relays : Operating Characteristics, Restraining Characteristics Analysis of Electromagnetic and differential Static relays schemes.

Bus zone Protection : Types of bus bar faults, Protection requirements, protection schemes and modern trend in bus-bar protection.

Circuit Breakers : Physical stress in circuit breakers, Vacuum circuit breakers, SF6, Circuit breakers Direct current C.B's Short circuit testing of circuit breakers. Comparison of different types of circuit breakers.

Recommended Books

1. T.S. Madhava Rao, Power System Protections (Static Relays), Tata McGrwaw-hill, 1989.
2. A.R. van C Warrington, Protective Relays, Chapman and Hall London, 1968.
3. S.K. Basu and S. Chaudhary, Power System Protection, Raju Primlan Oxford and IBH Press 1983.
4. Ravindra Nath M. Chander, Power System Protection and Switch Gear, John Wiley Eastern 1989.
5. Sunil S. Rao. Power System Protection and Switch Gear, Khanna Publishers 1989.
6. Related IEEE/IEE Publications.

Note :

1. **Eight questions, well distributed out of the entire syllabus are to be set.**
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		L : 4	Marks	Hrs.
ELE : 507	**Advanced Mathematics**	**Univ. Exam.**	**100**	**3**
		Sessional	**50**	

Operational Calculus : Laplace Transform, Inverse Laplace Transform, Convolution. z-Transform, Inverse z-Transform, Convolution Fourier Transform and its properties, convolution, and correlation Fourer Series and sampled waveforms. Discrete Fourier Transform (DFT), Discrete convolution and correlation Fast Fourier Transform (FFT) and its applications.

FFT convolutions and correlation, Two-dimensional FFT Analysis Systems of Ordinary Differential Equations, Difference Equations Concepts and applications to electric networks. Matrix representation and state variable approach. Non-linear Ordinary Differential Equations

The phase plane, conservation systems, structure of trajectory near-an-equilibrium point, periodic solution, limit cycles. Vander Pol equation, competing population. Volterra model

Probability and Statistics; Discrete Random variables; probability distributions, mean and standard deviation of discrete random variables Binomial coefficients. The binomial distribution. The mean and standard deviation of a binomial random variable.

Recommended Books :

1. Kaplan, W. " Advanced Mathematics for Engineers", Addison-Wesley Publishing Company (1981).
2. Brigham, E.O. "The Fast Fourier Transform and its Applications", Prentice-Hall (1988)
3. Widrow & Stearns, " Adaptive Signal Processing" Prentice-Hall (1990)
4. Weiss, N.A. and Hassett, M.J., " Introductory Statistics, Addison-Wesley Publishing Company (1993).
5. Related IEEE/IEE Publications.

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		L : 4	Marks	Hrs.
ELE : 508	**H . V. D. C. Transmission**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. H.V.D.C. Power Flow : Merits and Demerits of H.V.D.C. over E.H.V.A.C., Types of H.V.D.C. links. Control of H.V.D.C. links, Analysis of 3-phase bridge converter with grid control overlap angle U<= 60^o and U >= 60^o Derivation of equivalent circuit of H.V.D.C. link. Basic means of control of HVDC link, CCA, CC & CEA, Control Characteristic, combined characteristics of a converter.
2. Harmonics in H.V.D.C. operation, types of filters used for harmonic elimination.
3. Protection aspects of H.V.D.C. link.
4. Parallel operation of A.C. and D.C. systems.
5. Corone and R.I. Characteristics of H.V.D.C. link.
6. Stability aspects of synchronous and asynchronous link.

Recommended Books.

1. HVDC Power Transmission System, K.R, Padiyar, Wiley Eastern Ltd., 1990
2. E.W. Kimbark, Direct Current Transmission Vol: 1 Wiley Interscience, 1971.
3. J. Arrillage, H.V.D.C Transmission, Peter Peregrines, 1983.
4. J. Arrillage HVDC et. Al, Computer Modelling of Electrical Power System. John Wiley 1993.
5. S. Rao, EHV-AC and transmission Engineering practice, Khanna publishers, 1990.
6. Related IEEE/IEE publications.

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			L : 4	**Marks Hrs.**
ELE : 509	**Power System Stability**		**Univ. Exam .**	**100 3**
			Sessional	**50**

1. **Introduction :**

   Classification of electromechanical transients, Steady state, transient and resultant stabilities, basis for representation of power systems as two machines and multi-machine systems

2. **Steady state and transient characteristics of a two machine systems :**

   a. **P**hasor diagrams and expressions for active and reactive power in terms of voltages Eq. , EQ, E'q and Vg for salient and nonsalient pole machines (excluding resistance). Derivation of power expressions including resistance.
   b. Characteristics of sending and generator at synchronous speed.
   c. Characteristics of the generation at asynchronous speed.

3. **Steady state and transient characteristics of multi-machine systems**

   a. **C**haracteristics of linear system with machines running at asynchronous speed.
   b. Characteristics of linear system with machine running at synchronous speed.
   c. Characteristics of non-linear elements.

4. **Steady state stability of two machine systems**

   a. Unregulated case : Simple analysis of steady state stability, effect of damping and turbine regulation on small oscillations, effect of induced currents in field winding.
   b. Regulated case : Characteristics and types of excitation systems, forced excitation system, transfer function of automatically regulated synchronous machine, stability analysis with forced excitation regulator, influence of automatically regulated machine on the small oscillations in the systems.

5. **Steady state stability of multi-machine systems.**

6. **Transient stability of two machine systems**

   Equal area criterion, swing equation, approximate solution of swing equation, effect of excitation and turbine control.

7. **Transient Stability** of multi-machine system, transient stability of interconnected power systems, introduction to asynchronous operation of synchronous machines.

8. **Stability improvement measures in power systems.**

Recommended Books.

1. Transient phenomenon to power systems by Venikov V.A.

2. Introduction to Electrical Energy System by O.I. Elgerd.

3. Power System stability Vol I, II, III by Kimbark.

4. Power System Stability Vol. I, II by Crary,

5. Power System Analysis by Stevenson.

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		L : 4	**Marks**	**Hrs.**
ELE : 510	**E . H. V. AC Transmission**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

Introduction to E.H.V. A.C. Transmission, tower configurations, Thermal ratings of lines and cables, Transformer technology, Circuit breakers, Voltage gradients of conductors, corona effects, power loss and audible noise, Radio interference, Electrostatic field of transmission lines, Lighting and lighting protection, Insulation characteristics of long air gaps, Design of E.H.V. lines based upon steady state limits, Transient over-voltages, Voltage stability series and shunt compensation, Reactive power control apparatus.

Recommended Books

1. R.D. Begamudre, E.H.V. A.C. Transmission, Wiley Eastern Ltd., 2nd edition.
2. Transmission line Reference book 345 KV and above EPRI, Palo Alto, USA.
3. Electrical Transmission and Distribution Reference book, Oxford book Company, Calcutta.
4. S. Rao, EHV-AC and H.V.D.C. Transmission Engineering Practice, Khanna publishers, 1990.
5. Related IEEE/IEE Publications.

Note :

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ELE : 511 **Optimization Techniques**

	Marks	Hrs.
L : 4		
Univ. Exam .	**100**	**3**
Sectional	**50**	

1. **Introduction to Optimization**

Requirements for the Application of Optimization Methods, Defining the Systems Boundaries, The Perfarmance Criterion TheIndependent Variables, The System Model, Applications of Optimization in Engineering, Design Applications, Operations and Planning Applications, Analysis and Data Reduction Applications, Structure of Optimization Problems.

2. Functions of a Single Variable

Properties of Single – Variable Functions, Optimality Certeria, Region Elimination methods, Bounding Phase, Interval Refinement Phase, Comparison of Region Elimination Methods Requiring Derivations, Newton – Raphson method, Bisection Method, Secant Method, Cubic Search Method, Comparison of Method.

3. Functions of Several Variables

Optimality Certeria, Direct Search Method, The S^2 or Simplex Search Method, The hooke – Jeeves Pattern Search Method, Powell's Conjugate Direction Method, Gradient-Based Method, Cauchy's Method, Newton's Method, Modified Newton Method, Marquardt's Method, Canjugate Gradient method Quasi-Newton Methods, 'A Gradient- Based Algorithm, Numerical Gradient Approximation, Comparison of Methods and Numerical Results.

4. Linear Programming

Formulation of Linear Programming Models, Graphical Solution of Linear Programs in Two Variables, Linear Program in Standard Form, Handling Inequalities, Handling Unrestricted Variables, Principles of Simplex Method, Minimization Problems, Unbounded Optimum, Degeneracy and Cycling, Use of Artificial Variables, The Two Phase Simplex Method, Computer Solution of Linear Programs, Computer Codes, Computer Implementation of the Simplex Method, Computational Efficiency of the Simplex Method. Sensivity Analysis in Linear Programming, Applications, Additional Topics in Linear Programming, Duality Theory, The Dual Simplex Method, Integer Programming.

5. Constrained Optimality Criteria

Equality Constrained Problems, Lagrange Multipliers, Economic Interpretation of Lagrange Multipliers Kuhn-Tucker Conditions, Kuhn-Tucker Conditions of Kuhn-tucker, Problem, Interpretation of Kuhn-Tuker Conditions Kuhn Tuker Theorems, Saddlepoint Conditions, Second-Order Optimality Conditions.

6. Transformation Method

The Penalty Concept, Various Penalty Terms, Choice of the Penalty Parameter, R, Algorithms, Codes, and Other Contributions, The Method of Multipliers, The Penalty Function, Multiplier Update Rule, Penalty Function Topoligy, Termination of the Method, MOM Characteristics, The Choice of R-Problem Scale, Variable Bounds, Other MOM – Type Codes.

7. Constrained Direct Search

Problem Preparation, Treatment of Equality Constraints, Generation of Feasible Starting Points, Adaptations of Unconstrained Search Methods, Difficulties in Accommodation Constraints, The Complex Method, Discussion, Random Search Methods, Direct Sampling Procedures, Combined Heuristic Procedures.

8. **Linearisation Methods for Constrained Problems**

Direct Use of Successive Linear Programs, The Linearly Constrained Case, The General Non-linear Programming Case, Discussion and Applications, Separable Programming, Single-Variable Functions, Multivariable Separable Functions, Linear Programming Solutions of Separable Problems, Discussion and Applications, Cutting Plane Methods, The Basic Cutting Plane Algorithm, Kelley's Algorithm, Computational Aspects and Properties.

9. **Engineering Case Studies**

Optimal Location of Coal – Blending Plants by Mixed Integer, Programming, Problem Description, Model Formulation, Results, Optimization of an Ethylene Gylcol-Ethylene Oxide Process, Problem Description, Model Formulation, Problem Preparation, Discussion of Optimization, Runs, Optimal Design of a Compressed Air Energy Storage System, Problem Description, Model Formulation, Numerical Results.

Text Book

ENGINEERING OPTIMIZATION METHOD & APPLICATION

By : G.V. Reklaitis, A. Ravindra , KM Ragsdell, Wiley (1983)
Related IEEE/ IEE Publications.

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		L : 4	**Marks**	**Hrs.**
ELE : 512	**Microprocessors and Their Applications**	**Univ. Exam .**	**100**	**3**
		Sectional	**50**	

Microprocessor : Intel 8085 - Introduction, register structure, memory Addressing, Addressing Modes, Instruction Set, Timing Methods, CPU Pins and Associated Signals, Instruction timing and execution, programming I/O, Interrupt System, DMA, SID & SOD lines, Instruction set, 8085, based system design, Intel 8086, - Introduction Architecture, Addressing modes, instruction set memory management, assembler dependent instructions, Input/Output, system design using 8086.

Peripheral Interfacing : Parallel versus serial transmission, synchronous and asynchronous serial data transmission, Interfacing of hexadecimal keyboard and display unit, interfacing of cassette recorders and CRT. Parallel, serial interface standards.

Microprocessor applications to power Engg.

Protective relaying : over-current, impedance, MHO, reactance, bi-directional relays.

Measurements : Frequency, power angle & power factor, Voltage and Current, KVA, KW, & KVAR, maximum demand, Resistance, Reactance, Temperature Controls.

Recommended Books :

1. Rafiquzzaman, M. Theory & Applications PHI Publications 1993.
2. Gaonkar R. S. Microprocessor Architecture, Programming and Applications John Wiley 1989.
3. Ram B. Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai & Sons 1995.
4. Liu Yu Cheng and Gibson, G.A. PHI 1992.
5. Leventhal, L.A. Introduction to Microprocessors : Software , Hardware, Programming.
6. Related IEEE/IEE Publications.

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ELE : 513 **Applied Instrumentation**

	L : 4	Marks	Hrs.
	Univ. Exam .	100	3
	Sectional	50	

1. Transducers, Classification of Transducers, including analog and digital transducers, Selection of Transducers Static and Dynamic response of transducer System.

2. Measurement of length & thickness, linear Displacement, Angular Displacement, force, weight, torque, Moisture, Level, Flow, pH & Thermal Conductivity, Measurement of Frequency Proportional, Geigermuller & Scintillation Counters.

3. Telemetry : Basic Principles, Proximity & remote Action Telemetry systems, Multiplexing, Time Division and frequency division.

4. Various types of Display Device, Digital Voltmeters, Dual Slope DVMS, Digital encoders, Analog and Digital encoders, Analog and Digital Data Acquisition System, A/D Converter.

5. Fibre Optic Technology for data transmission, Supervisory Control and Data Acquisition Systems (SCADA), Q-meter.

6. Electrical noise in control signals, its remedial measures.

Recommended Books

1. W.D. Coopper & A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, PHI.
2. B.C. Nakra and K.K. Choudhary, Instrumentation Measurement Analysis, Tata McGraw-Hill.
3. Instrument Transducers by Hermann, K.P. Neubert.
4. Electrical Transducers for Industrial Measurement by pH Mansfield.
5. Instrumentation systems by Mani Sharma, Rangan.
6. Principles & Methods of Telemetry by Borden & & Thgnel.
7. Telemetry Method by Foster.
8. Related IEEE/IEE Publications.

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ELE : 514 **Fast Transients in Power Systems**

	L : 4	Marks	Hrs.
	Univ. Exam .	100	3
	Sectional	50	

1. Origin and nature of power system Transients, Traveling waves on transmission system. The line equation. The shape attenuation and distortion of waves, reflection of traveling waves, Successive reflections, Traveling waves on multi-conductor systems, Transition points on multi conductor circuits.

2. Lightning : Change formation, Mechanism of lighting stroke, Mathematical model of lightning stroke.

3. Theory of Ground Wires : Direct Stoke to a tower, Effect of reflection up and down the tower, The counterpoise.

4. Switching Surges : Normal frequency effects, High charging currents, cancellation waves, Recovery voltage, Restricting phenomena.

5. Protection of transmission systems against surge.

6. High frequency oscillations and terminal transients of transformer.

7. Insulation co-ordination.

References

1. L.V. Bewley, Traveling waves on transmission systems, power Publication Inc New York, 1963.
2. R. Rudenterg, Electric Stroke waves in Power Systems, Harvard University Press, Cambridge, Massachusetts, 1968.
3. Allan GreenWood, Electrical Transients in Power Systems, Wiley Interscience, 1971.
4. EPRI, Transmission Line reference Book 345 KV and above, 1984.
5. Surge Protection in Power Systems. IEEE Publication, 79 EHD 144-46 PWR.
6. Regaller K. Surges in High Voltage Networks, Plenum Press, 1980.
7. Related IEEE/IEE Publications.

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2. **Five questions are to be attempted.**

		L : 4	**Marks**	**Hrs.**
ELE : 515	**Energy Efficient Machines**	**Univ. Exam .**	**100**	**3**
		Sectional	**50**	

1. Introduction : Need for energy efficient machines, energy cost and two part tariff, energy conservation in industries and farms a necessity, introduction to energy management and energy audit system.

2. Review of induction motor characteristics.

3. Energy Efficient motors : Standard motor efficiency, Why more efficient motors, An energy efficient motor, Loss segregation method, Comparison, motor efficiency labeling, energy efficient motor standards.

4. The power factor : The p.f. in sinusoidal systems, p.f. improvement, the p.f. with non-linear loads, Harmonics and the p.f. , p.f. motor controllers.

5. Application of Electric motors : Varying duty applications, Voltage variation, Voltage Unbalance, Overmotoring , Poly-phase induction motors Supplied by adjustable frequency power Supplies.

6. Induction motors and adjustable drive Systems : Energy Conservation, adjusted speed systems, Application of adjustable speed systems to fans, pumps and constant terque loads.

7. Economics of Energy Efficient motors and systems : Motor life cycle, Directo Savings and pay back analysis, efficiency evaluation factor, present worth method with Constant power costs, present worth method with increasing power costs, net present worth method.

Recommended Books

1. John C. Andreas, Energy efficient electric motors, Marcel Dekker Inc. 1992.

2. Albert Thuman, Introduction to Efficient Electric System Design, The Fairmount Press Prentice – Hall.

3. S.C. Tripathi, Electric Energy Utilization and Conservation, Tata McGrwa-Hill 1991.

4. Charles Belove, Handbook of Modern Electronics and Electrical Engineering, John Wiley & Sons.

Note :

1. **Eight questions, well distributed out of the entire syllabus are to be set.**
2. **Five questions are to be attempted.**

		L : 4	Marks	Hrs.
ELE : 516	**Advanced Electrical Drives**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. Introduction : Concept and classifications, Selection.

2. Dynamics of Electrical Drives : Loads, Quadrantal diagram of speed-torque Characteristics, Load torque variation, Dynamics of motor load combination, Steady state and transient Stability of an electric drive.

3. Review of motor Characteristics : Modified speed-torque characteristics of d.c. shunt and series motors, Modified speed – torque characteristics of three phase induction motors, Variation of applid voltage, Variation of Supply frequency.

4. **Starting :** Review of motor starting methods, Acceleration time, Energy relation.

5. **Electric Braking : R**eview of electric braking of three phase induction motor Energy relation, Dynamics of Braking, Thyristor Controlled Electrical Drives.

6. **D.C. Motor Drives :** Controlled rectifier d.c. drives, Chopper-fed d.c. motor drives, Separately excited and series motors, Steady State Performance.

7. **Induction Motor Drives :** Variable frequency control, slip power control, Chopper controlled resistance in the rotor Circuit.

8. **Industrial Applications :** Steel mills, Hot and Cold rolling mills, Paper Mills, Cement Mills.

Recommended Books

1. A first Course on Electrical Drives by S.K. Pillai, Wiley Eastern.
2. Thyristor control of Electric Drives by V. Subrahmanyam, Tata McGraw-Hill.
3. Thyristor d.c. drives by S.K. Sen.
4. Electric Machines and Drives by Fransua.
5. Control System in Industry by Siskind, McGraw-Hill.
6. Related IEEE/IEE Publications.

Note :

1. **Eight questions, well distributed out of the entire syllabus are to be set.**
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		L : 4	Marks	Hrs.
ELE : 517	**Non-Conventional Energy Systems**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. **Introduction to Energy Sources** :

World Energy Futures, Conventional Energy Sources, Non-Conventional Energy Sources, Prospects of Renewable Energy Sources.

2. **Solar Energy** :-

   a. Introduction to Solar Radiation and its measurement, Introduction to Solar Energy Collectors and Storage.
   b. Applications of Solar Energy : Solar Thermal Electric Conversion, Thermal Electric Conversion Systems, Solar Electric Power Generation, Solar Photo-Voltaics, Solar Cell Principle, Semiconductor Junctions, Conversion efficiency and power output, Basic Photo-Voltaic System for Power Generation.

3. **Wind Energy** : -

   a. Introduction to wind energy Conversion, the nature of the wind, Power in the wind.
   b. Wind Energy Conversion : Wind data and energy estimation, Site Selection Considerations, Basic Components of a Wind Energy Conversion System, Classification of WEC Systems, Schemes for Electric Generation using Syhchronous Generator and Induction Generator, Wind energy Storage.

4. **Direct Energy Conversion Processes** :-

   a. Magneto Hydro Dynamic Power Generation : Principles of MHD power generation, Open Cycle Systems, Closed Cycle Systeous Voltage and power output, Materials for MHD generators.
   b. Thermo-Electric Generation : Basic principles of thermo-electric power-generation, Seeback, Peltier, Thomson effects, Thermo-Electric power generator, Analysis, materials.
   c. Thermonic Generation : Thermonic emission and work function, Basic thermonic generation.
   d. Fuel Cells H2, O2 Cell, Classification of fuel Cells, Types, Advantages, Electrodes, Polarization.
   e. Thermo Nuclear Fusion Energy : The basic Nuclear Function and Reactions Plasma Confinement, Thermo Nuclear Function Reactions.

5. **Energy From Biomass** : -

   a. Introduction : Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-ges plants.
   b. Biomass as a Source of Energy : Method for obtaining energy from Bio-mass, Bio-Logical Conversion of Solar Energy.

Recommended Books

Non-Conventional Sources of Energy By : G.D. Rai, Khanna Publishers**.**

Reference Books

1. Bio Energy by David Boyles, Elis Horwood Ltd.,
2. Renewable energy sources and conversion technology by N.K. Bansal, M. Kleemann, M. Heliss, Tata Mc-Graw-Hill 1990.
3. Direct Energy Conversion by R. A. Coombie, Pitman.
4. Learning about Energy by David J. Rose, Plenum Press 1986.
5. Bio Energy Spectrum, Bio Energy and Wasteland Development Organization by O.P Vimal and P.D. Tyagi.
6. Related IEEE/IEE Publications.

Note :

1. **Eight questions, well distributed out of the entire syllabus are to be set.**
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		L : 4	Marks	Hrs.
ELE : 518	**Power System Reliability**	**Univ. Exam**	**100**	**3**
		Sessional :	**50**	

1. **Introduction**

Reliability definition, Modes of Systems failure, Reliability Indices, Storage ability maintain ability, Service life, Redundancy.

2. Basic Probability Theory

Forms of system failure-simple flow, non-stationary Poisson low, Laws of distribution-Binomial distribution, Poisson's distribution, Normal Raleigh's laws, Gamme distribution, Weibull distribution, Markov process (Discrete and Continuous)

3. **Reliability Concepts, Models and Evaluation**

General reliability function, exponential distribution MTTF, MTBF, Hezard rate. Series systems, Parallel systems, Series Parallel system, Time Dependence, Reliability evaluation, Standby systems, Rout of p configurations. Methods of tie sets and cutsets of reliability evaluation, Simulation and Reliability Prediction, Monte Carlo Method, Rearsive techniques, Non-Markonian Process.

4. **Static Generating Capacity Reliability Evaluation :**

Capacity outage tables, loss of load probability approach, load forecast uncertainty, loss of energy probability, frequency and duration approach.

5. Spinning Generating Capacity Reliability Evaluation :

Spinning Capacity Evaluation, Load Forecast Incertainty, Derated Capacity Levels.

6. Transmission System Reliability Evaluation:

Average Interruption Rate Method, Frequency and Duration Method Stormy and Normal weathers effects, Markov Process approach and its comparison with Approximate method.

Recommended Books :

1. R.Billinton & R.N. Allan, " Reliability evaluation of Engineering Systems, Concepts and techniques." Pittnan Books 1983.

2. R.Billinton & R.N. Allan, " Reliability evaluation of Power Systems, Pittnan Books 1984.
3. C.Singh & R. Billinton, System Reliability Modeling and Evaluations, Hutchinson of London, 1977.
4. E.E. Lewis, Introduction to Reliability Engineering, John Wiley & Sons, 1987.
5. S. Krishana Swami, Probabilistic Method to Electric Power Systems, Pergamon Press, 1987.
6. J. Endrenyi, Reliability Modllling in Electric Power Systems, John Wiley & Sons, NY. 1979.
7. Dr. A.K. Aggarwal, Reliability Engineering, 1992.
8. Govil, Reliability Engineering, 1992.
9. Related IEEE/IEE Publication.

Note :

1. ***Eight questions, well distributed out of the entire syllabus are to be set.***
2. ***Five questions are to be attempted.***

ELE : 519 **Power System Planning**

L : 4	**Marks**	**Hrs.**
Univ. Exam .	**100**	**3**
Sessional	**50**	

1. **Introduction** : Review of load forecasting, the electric utility industry, growth characteristics generation, transmission and distribution systems.

2. **Generation System Planning**
   Optimal Scheduling of Generation units, Optimal Power Flow, Optimal Scheduling of hydor-thermal power system, Unit commitment, Reliability based generation system, expansion planning, unit maintenance schedule, unit effective load carrying capability, generation system cost analysis.

3. **Transmission System Planning : A**utomatic Transmission System Expansion Planning, Automatic Transmission Planning using Interactive Graphics.

4. **Distribution System Planning and Automation : L**oad Characteristics, Design of Subtransmission lines and distribution, substations, Design Considerations of Primary and secondary distribution systems, Voltage drop and power loss Calculations, Distribution system Voltage regulation, application of capacitors to distribution systems.

Recommended Books

1. R.L. Sullivan, Power System Planning, McGraw Hill International Book Co., 1977.
2. A.S. Pabla, Electrical Power System Planning Macmillan (1998)
3. Related IEEE/IEE Publications.

Note :

1. **Eight questions, well distributed out of the entire syllabus are to be set.**
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		L : 4	**Marks**	**Hrs.**
ELE : 520	**Power System Communication**	**Univ. Exam .**	**100**	**3**
		Sessional	**50**	

1. Introduction : Communication links required in telemetry, tele-control and tele-protection.
2. Analog and Digital Communication : Speed and **banding** requirements, Noise in Power Systems.
3. Communication Links : PLCC, Microwave, Telephone Line, Satellite. Fiber Optic.
4. Requirements of Various Communication Equipments used in Power Systems.
5. Computer Networking in Power Systems.

Recommended Books

1. Data and Computer Communication by William Stallings, PHI, 1994.
2. Optical Communications Systems by John Gowar, PHI, 1993.
3. Foundations of Microwave Engineering by R.E. Collin.
4. Wireless Communication, Principles and Practice : Theodore S. Rappaport, IEEE Press; PH PTR, 1996
5. Wireless Digital Communications : K. Feher, PH, 1995.
6. Related IEEE / IEE Publications.
7. Computer Network by **Tanenbeum**
8. Related IEEE/IEE Publications.

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