Punjab Technical University

Jalandhar

TEACHING SCHEDULE & STUDY SCHEME

M.TECH PROGRAMME

(Power Engineering)

(To be applicable for M. Tech. admission for session July/Aug-2004 and onwards)

Regional Centre of Punjab Technical university, Jalandhar

M. Tech (Power Engg.)

PREAMBLE

There is a need of qualified faculty (Ph. D. and M. Tech) in various fields of Engineering and Technology. Punjab does not have many institutions offering PG Courses in Engineering and Technology. Keeping this fundamental need in mind, the University has ventured in establishing regional centres in strategic locations in the state of Punjab to offer M.Tech and Ph. D. programmes for the teachers in various technical institutions in the state of Punjab.

The scheme of M. Tech (Power Engineering) will consist of 8 Nos. core courses and 4 Nos. Professional (Elective) Courses besides 2 Nos. Lab courses, Project /Seminar and dissertation. The structure of the courses shall be as follows :

Semester	**No. of Courses**	**Contact hours per Course per week.**
1st	5 Theory Courses+ 01 Lab Course	04
2nd	3 Compulsory Courses+ 02 Elective Courses*+ 01 Lab Course	04
3rd	2 Elective Courses** +Project +Seminar	04 04 02
4th	Dissertation	02 Hrs./Week

*** 02 Elective Courses are to be selected from the list of Electives-I & Electives-II:**
****02 Elective Courses are to be selected from the list of Electives-III & Electives-IV:**

M. Tech (Power Engineering) Degree Shall be of 2200 marks. For project there shall be 50 internal and 50 external marks and Seminar will be of 100 internal marks. There shall be no marks for dissertation and dissertation shall be evaluated as satisfactory/unsatisfactory.

Punjab Technical University, Jalandhar
(Regional Centers)

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M. Tech (Power Engineering) Full Time/Part Time
Course Structure and Scheme of Evaluation
(To be effective w.e.f. M.Tech admissions for the session July/Aug-2004 and onwards)

1st Semester:

Code No.	Name of Subject	Hrs/Week	Evaluation (Marks)		
			Internal Marks	External Marks	Total
PEE-501	Power System Operation & Control	4	50	100	150
PEE-502	Advanced Power System Analysis	4	50	100	150
PEE-503	Advanced Power Electronics	4	50	100	150
PEE-504	Digital Control Systems	4	50	100	150
PEE-505	Advanced Electrical Machines	4	50	100	150
PEE-506	Power System Software Lab	4	50	50	100

Total Marks = 850

2nd Semester:

PEE-507	Advanced Mathematics	4	50	100	150
PEE-508	H.V.D.C. Transmission	4	50	100	150
PEE-509	Power System Protection	4	50	100	150
PEE-510	Industrial Automation Lab	4	50	50	100
PEE-	Elective-I	4	50	100	150
PEE-	Elective-II	4	50	100	150

Total Marks = 850

3rd Semester:

PEE-	Elective –III	4	50	100	150
PEE-	Elective-IV	4	50	100	150
PEE-511	Project	4	50	50	100
PEE-512	Seminar	2	100	-	100

Total Marks = 500

4th Semester:

PEE-600	Dissertation	-	-	-	-

LIST OF ELECTIVE COURSES

ELECTIVE-I

		Hrs/Week	Int. Marks	Ext. Marks	Total
PEE-513	Power Systems Stability	4	50	100	150
PEE-514	E.H.V.A.C. Transmission	4	50	100	150
PEE-515	Reliability Engg.	4	50	100	150

ELECTIVE-II

PEE-516	Microprocessors and their applications	4	50	100	150
PEE-517	Applied Instrumentation	4	50	100	150
PEE-518	Fast Transients in Power Systems	4	50	100	150

ELECTIVE-III

PEE-519	Energy Efficient Machines	4	50	100	150
PEE-520	Advanced Electrical Drives	4	50	100	150
PEE-521	Non-Conventional Energy Sources	4	50	100	150

ELECTIVE-IV

PEE-522	Power System Reliability	4	50	100	150
PEE-523	Power System Planning	4	50	100	150
PEE-524	Power System Communication	4	50	100	150
PEE-525	Optimization Techniques	4	50	100	150
PEE-526	Neural Networks & Fuzzy Logic	4	50	100	150

PEE-501 POWER SYSTEM OPERATION & CONTROL

	Marks	Hrs.
L:4		
Uni. Exam.	100	3
Sessional	50	

1. **Characteristics of Power Generation Units :**
   Characteristics of steam units, variation in steam unit characteristics, cogeneration plants, Hydro electric units.
2. **Economic Dispatch of Thermal Units:**
   Economic Dispatch Problem, Thermal dispatching with network losses considered, penalty factors , lambda iteration method , Gradient method, Newtons method , Dynamic Programming , Base point and participation factors. Economic dispatch vs unit commitment ,constraints in unit commitment . Introduction to optimal power flow, Solution of optimal power flow by gradient method.
3. **Hydro Thermal Co-ordination :**
   Introduction to long range and short range hydro scheduling, Types of short range scheduling problem, Scheduling energy. The short term hydro-thermal scheduling problems and its solution by Lambda-Gamma iteration method and gradient method.
4. **Generation Control :**
   Generator ,Prime mover, Governor ,Tie line and load models ,Load frequency control, Load frequency and economic dispatch control, Automatic voltage Control, Load frequency control with generation rate constraints, Decentralized control.
5. **Interchange of Power and Energy:**
   Economy Interchange between Inter connected utilities, Inter utility Economy Energy Evaluation , Capacity Interchange, Diversity Interchange, Energy Banking, Emergency Power Interchange, Power pools, Transmission Effects and Issues.

Books:-

1. Allen J. Wood and Brace F woollenberg, Power Generation Operation and Control, John Willey & Sons 2nd Edition .
2. D.P. Kothari and J.S. Dhillon, Power System Optimization, Prentice-Hall of India, Pvt. Ltd,. New Delhi
3. L.K .Kirchmayer, Economic Operation of Power Systems, John Willey & Sons, N.Y.
4. D.P. Kothari and I.J. Nagrath , Modern Power System Analysis ,Tata Mc Graw-Hill Publishing Company Ltd., New Delhi.

Note:

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

PEE-502 Advanced Power System Analysis

L:4	Marks	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. Incidence and network matrices, formation of network matrices by singular and non-singular transformation.

2. Algorithm for formation of single phase Bus Impedance Matrix.

3. Three- phase balanced network elements, Transformation matrices , Three phase unbalanced network elements , Algorithm for formation of three phase Bus Impedance Matrix.

4. Short circuit calculations using Z-BUS for balanced and unbalanced three phase networks, symmetrical components, sequence impedances, sequence networks, Unbalanced fault analysis for three phase to ground fault, LG fault, LL Fault, LLG Fault.

5. Load flow studies using Y-BUS, Gauss-Seidel method ,Newton Raphson method, Fast Decoupled load flow method , representation of transformers, Sparsity technique.

6. Contingency Analysis for power systems using Brown's method, State estimation from on line measurements, The line power flow state estimation.

Books:-

1. G.N. Stagg and A. H.EI- Abiad , Computer Methods in Power System Analysis, McGraw –Hill ,International Edition .
2. George L .Kusic, Computer Aided Power Systems Analysis ,Prentice Hall.
3. J. Arrillaga, C.P. Arnold and S.J. Harker, Computer Modelling of Electrical Power Systems, John Willey and Sons.
4. O.I. Elgerd Electric Energy Systems -An Introduction, Tata McGraw Hill.
5. M.A. Pai, Computer Techniques in Power Systems Analysis ,Tata McGraw Hill.
6. P.M. Anderson, Analysis of Faulted Power System, IEEE Press Book.
7. Related IEEE/IEE Publication.

Note:

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PEE: 503 Advanced Power Electronics

	L: 4	Marks	Hrs.
Uni. Exam.		100	3
Sessional		50	

I. 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 -1 Characteristics, Turn ON & Turn OFF Characteristics, di/dt and dv/dt protection, Series and Parallel Operation of Thyristors, Thyristor firing circuits, UJT and PUJT, Thyristor commutation Techniques.

3. Power Transistors:

Bipolar Junction Transistors, their steady State & Switching Characteristics, Power MOSFET'S and their steady state & switching characteristics, Gate drive SIT's & IGBTS's, Series & Parallel Operation, di/dt and dv/dt limitations,

4. Controlled Rectifiers:

Single Phase & Three Phase full Converters 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, Chopper Circuit Design.

7. PWM Inverters:

Principle of Operation, Performance parameters, single phase bridge invertors and their voltage Control, Harmonic Reduction, Inverter Circuit Design.

Recommended Books:-

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

Note

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PEE-504 DIGITAL CONTROL SYSTEMS

	L: 4	MARKS	HRS.
Uni. Exam.		100	3
Sessional		50	

1. Introduction:
Configuration of the basic Digital Control Systems, types of sampling operations, Sample and Hold operations, Sampling theorem, Basic discrete time signals.

2. Analysis of Digital Control Systems :
Z-Transforms, Properties of Z-Transform, Inverse Z-Transforms, Pulse Transfer Function, Difference equations, Z-Transform method for solving the difference equations, Block diagram and signal flow graph analysis, Time response of digital control systems .

3. Stability Methods :
Mapping between s-plane and z-plane, stability methods: Modified Routh Criterion, Jury's method, modified Schur-Cohn criterion.

4. Models of Digital Control Systems :
Digital temperature control System ,Digital position control system ,stepping motors and their control.

5. Design of Digital compensator using frequency response plots.

6. Control Systems Analysis Using State Variable Methods :
State variable representation, conversion of state variable models to transfer function and vice-versa, Eigen values and eigen vectors, Solution of state equations, Concepts of controllability and observability.

7. State Variable analysis of Digital Control Systems :
State variable description of digital control systems , conversion of state variable models to pulse transfer function and vice versa , solution of state difference equations, controllability and observability.

Recommended Books :

1. M. Gopal, Digital Control and State Variable Methods, Tata Mc-Graw-Hill.
2. K.Ogata, Discrete Time Control Systems, Pearson Education, (Singapore) (Thomson Press India).
3. B.C Kuo , Digital Control Systems , Prentice Hall.
4. I.J. Nagrath & M.Gopal , Control System Engg., John Wiley & sons.
5. K.K. Aggarwal, Control System Analysis and Design, Khanna Publishers.

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

PEE: 505 Advanced Electrical Machines

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

1. Polyphase Synchronous Machines:

- **a. Mathematical Modelling:** Basic Synchronous machine parameters, Voltage, Flux linkage and inductance relations, Park's transformation - its physical concept, equations of performance.
- **b. Balanced Steady State Analysis:** Phasor equations and phasor diagrams, Power-angle characteristics, cylindrical rotor and Salient pole machines, Short circuit ratio.
- **c. Transient Analysis:** Three phase short circuit Armature and field transients, Transient torque, Sudden reactive loading and Unloading. Transient Analysis -a qualitative approach, Reactances and time , constants from equivalent circuit .Measurement of Reactances, Transient Power angle characteristics.
- **d. Synchronous - 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:** Harmonics 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. Edkins.
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 (Westinghouse reference book,)
8. Electromagnetic transients by Adkins and Hoffman,)
9. Related IEEE/IEE Publications.

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2. Five questions are to he attempted.

PEE-506 POWER SYSTEM SOFTWARE LAB

	Marks	Hrs/Week
Int.	50	04
Ext.	50	

Development of algorithms & flowcharts and digital simulation of the following using ETAP/MATLAB Software package:

1. Z-bus and Y-bus formulation
2. Load flow studies
3. fault analysis
4. Transient stability studies.

PEE: 507 ADVANCED MATHEMATICS

L: 4	Marks	Hrs.
Uni. Exam	100	3
Sessional	50	

Operational Calculus: Laplace Transform, Inverse Laplace Transform, Convolution, z-Transform, Inverse z Transform, Convolution.

Fourier Transform :Properties, convolution, and correlation, Fourier 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.

Differential Equations :Systems of Ordinary Differential Equations . Difference Equations, Concepts and applications to electric networks, Matrix representation and state variable approach.

Non-linear Ordinary Differential Equations: 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 Book:

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.

Note:

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2. Five questions are to be attempted.

PEE-508 H.V.D.C. TRANSMISSION

L: 4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. **H.V.D.C. Power Flow:** Merits & Demerits of H.V.D.C. over E.H.V. A.C., types of HVDC links.

2. Converter connection, rectifier & inverter waveforms, Complete analysis of 3-phase (6 pulses) bridge converter. Equations of voltage & current on AC& DC side.

3. Equivalent Circuit of HVDC link, Basic means of control of HVDC link, CIA, CEA&CC, control characteristics, combined characteristics of a converter.

4. Reactive Power compensation in HVDC substation.

5. Fundamentals of Harmonics and Harmonic filters.

6. Stability aspect of synchronous & asynchronous link.

7. Introduction to multi-terminal HVDC systems.

8. Protective system in HVDC substations.

Recommended Books:

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

Note:

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2. Five questions are to be attempted.

PEE: 509 Power System Protection

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

Fundamentals: Types of relays, their classifications and theory Phase and amplitude comparators. Static Comparators Computer Applications 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 Protection (Static Relays), Tata McGraw-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 Nalh 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.
2. Five questions are to be attempted.

PEE-510 Industrial Automation Lab

	Marks	Hrs
Int.	50	04
Ext.	50	

1. Programmable Logic Controller(PLC) –General introduction, basic concepts, different types of programming: ladder programming. Instruction List programming, High level programming ,flow diagram programming .

2. Simple introductory programs.

3. Use of PLC for: Simple domestic or commercial lighting automation ,water level control.

4. Industrial applications of PLC using Timer and Counter Function.

5. Study & use of SCADA Software for different process control systems.

Books:
1. Control Engg.-by Noel M. Morris.
2. Industrial Electronics-by Thomas E. Kissell, PHI, N. Delhi.

PEE-511 PROJECT

Hrs/Week: 04
Int. Marks: 50
Viva/Ext. Marks 50

Students will undertake hardware/software project work keeping in view the recent trends of Research/development related to power Engg/Electrical Engg.

Note: No theory exam. is to be conducted.

PEE-512 SEMINAR

Hrs./Week: 2
Int. Marks : 100
Ext. Marks: Nil

Students will undertake an extensive study of/from National/International journals, Internet etc. related to a latest topic in the area of Power Engg. and will deliver a seminar on the relevant topic.

Note:- No theory Exam. is to be conducted.

PEE-513 Power System Stability

	Marks	Hrs.
L: 4		
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 system.

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

a) Phasor diagrams and expressions for active and reactive power in terms of voltages Eq., Eq', and Vg for salient and non salient pole machines (excluding resistance). Derivation of power expressions including resistance.

b) Characteristics of sending end generator at synchronous sPEd.

c) Characteristics of the generator at asynchronous sPEd.

3. Steady State and transient characteristics of multi-machine system:

a) Characteristics of linear system with machines running at asynchronous sPEd.

b) Characteristics of linear system with machine running at synchronous sPEd.

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 systems, 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.

Note:

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

PEE-514 EHV AC TRANSMISSION

L: 4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

Introduction to EHV AC Transmission, Tower Configurations, types of self supporting Lattice towers, Flexible and Semi Flexible towers.

Thermal Rating of Lines, Temperature rise of conductors and current carrying capacity of lines and cables, properties of bundled conductor, Average value of line parameters, power handling capacity and line loss, selection of cable for EHV AC transmission, Electrical characteristics and cable insulating materials . Types of circuit breakers for EHV AC system.

Voltage gradient of conductors: field of line charges and their properties , surface voltage gradient on conductors, maximum surface voltage gradient . Corona Effects, Corona formulas based on voltages and voltage gradients, Corona currents, Power loss, Audible Noise and Radio interference , Limits of audible noise, AN measurements ,day night equivalent noise level.

Electrostatic field of EHV lines: Capacitance of long objects under transmission lines, electrostatic field of 3 phase single circuit and double circuit AC lines, Biological effects of electrostatic fields.

Lightning and Lightning Protection : Over voltage factors, type of surge arresters, rating and classification of surge arresters based on applications , insulation withstand characteristics of long air gaps.

Design of EHV Lines based on Steady-State limits, transients, voltage stability, series and shunt compensation, reactive power control apparatus.

Recommended Books:

1. R.D. Begamudre , EHV AC 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 HV DC Transmission Engineering Practice, Khanna Publishers.
5. Related IEEE/IEE Publications.

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PEE-515 Reliability Engg.

L: 4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. **Reliability Mathematics:**
   Random experiments, probability, random variables, distribution functions , discrete distributions ,Continuous distributions.
2. **Network Modelling and reliability evaluation of simple systems:**
   Series systems, parallel system, series-parallel systems, partially redundant systems, standby redundant systems.
3. **Networks and reliability evaluation of complex systems:**
   Cut set method, Tie-set method, Connection matrix techniques, Event trees, Fault trees.
4. **Probability distributions in reliability Evaluation:**
   General reliability function ,Poisson distribution, normal distribution, exponential distribution.
5. **Discrete Markov Chains:**
   General modelling Concept, Stochastic transitional prob. matrix, Time dependent prob. evaluation, Limiting state Prob. evaluation, Absorbing States.
6. **Continuous Markov Processes:**
   General modeling concepts, state space diagrams, Stochastic transitional probability matrix, Evaluating limiting state probabilities.

Books:-

1. L.S. Srinath, Reliability Engineering, Affiliated East –West Press Pvt. Ltd., New Delhi
2. E. Balagurusamy, Reliability Engineering, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. R. Billinton & Ronald N. Allan ,Reliability Evaluation of Engg. Systems: Concepts & Techniques, Plenum Press, N.Y. and London.

Note:

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4. Five questions are to be attempted.

PEE: 516 Microprocessors and Their Applications

L: 4	**Marks**	**Hrs.**
Univ. Exam.	**100**	**3**
Sessional	**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 or hexadecimal keyboard and display unit, interfacing of cassette recorders and 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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E: 517 Applied Instrumentation

	Marks	Hrs.
L: 4		
Univ. Exam.	**100**	**3**
Sessional	**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. Cooper & A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, PHI.
2. B.C. Nakra and K.K. Chaudhary, Instrumentation Measurement Analysis, Tata McGraw-Hill.
3. Instrument Transducers by Hermann, K.P. Neubert.
4. Electrical Transducers for Industrial Measurement by pH Mansfleld.
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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PEE: 518 Fast Transients in Power Systems

	Marks	Hrs.
L: 4		
Univ. Exam.	**100**	**3**
Sessional	**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 ref1ections, Traveling waves on multi-conductor systems. Transition points on multi conductor circuits.

2. **Lightening:** Charge formation. Mechanism of lightening stroke, Mathematical model of lightening stroke.

3. **Theory or Ground Wires:** Direct Stroke 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 Books:

1. L.V. Bewley, Traveling waves on transmission systems, power Publication lnc New York, 1963.
2. R. Rudenterg, Electric Stroke waves in Power Systems, Harvard University Press, Cambridge, Massachusetts, 1968.
3. Allan Green Wood, Electrical Transients in Power Systems, Wiley lnterscience, 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.

Note:

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

PEE: 519 Energy Efficient Machines

	Marks	Hrs.
L: 4		
Univ. Exam.	100	3
Sessional	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, efficiency determination methods, Direct Measurement method, 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.

5. **Application of Electric motors:** Varying duty applications, Voltage variation, Voltage Unbalance, Over motoring, Poly-phase induction motors supplied by adjustable frequency power supplies.

6. **Induction motors and adjustable drive Systems**: Energy Conservation, adjustable sPEd systems, Application of adjustable sPEd systems to fans, pumps and constant torque loads.

7. **Economics of Energy Efficient motors and systems:** Motor life cycle, Direct 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 McGraw-Hill 1991.
4. Charles Belove, Handbook of Modem 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.

PEE: 520 Advanced Electrical Drives

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

1. **Introduction:** Concept and classifications, Selection.

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

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

4. **Starting:** Review of motor starting methods, Acceleration time, 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 IFEE/IEE Publications.

Note:

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

PEE: 521 Non-Conventional Energy Sources

	Marks	Hrs.
L: 4		
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 Synchronous 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 Systems, Voltage and power output, Materials for MHD generators.
   b) Thermo-Electric Generation: Basic principles of thermo-electric power-generation, Seebeck, Peltier, Thomson effects, Thermo-Electric power generator, Analysis, materials.
   c) Thermionic Generation: Thermionic emission and work function, Basic thermionic generation.
   d) Fuel Cells $H_2 O_2$ **C**ell, 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-gas plants.
   b) Biomass as a Source of Energy: Method for obtaining energy from Bio-mass, Biological Conversion of Solar Energy.

Reference Books:

1. Non-Conventional Sources of Energy by :G.D. Rai, Khanna Publishers.
2. Bio Energy by David Boyles, Elis Horwood Ltd.,
3. Renewable energy sources and conversion technology by N.K. Bansal, M. Kleemann, M. Heliss, Tata McGraw Hill 1990.
4. Direct Energy Conversion by R. A. Coombie, Pitman.
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.
2. Five questions are to be attempted.

PEE-522 Power System Reliability

L:4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. **Basic Reliability Concepts:**
   The General reliability function, Hazard rate, MTTF, Markov processes.

2. **Static Generating Capacity Reliability Evaluation:**
   Capacity outage probability tables, loss of load probability method, Frequency and duration approach.

3. **Spinning Generation Capacity Reliability Evaluation:**
   Spinning capacity evaluation, Load forecast uncertainty, Derated capacity levels.

4. **Transmission System Reliability Evaluation:**
   Average interruption rate method, Frequency and duration method, Stormy and normal weather effects , The Markov process approach .

5. **Composite System Reliability Evaluation**
   Conditional probability approach ,two –plant single load system.

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, Pittman Books 1984.
3. C. Singh & R. Billinton, System Reliability Modelling and Evaluations, Hutchison of London 1977.
4. J. Endrenyi, Reliability Modelling in Electric Power Systems, John Wiley & Sons, NY. 1979.

Note:

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

PEE: 523 Power System Planning

	Marks	Hrs.
L: 4		
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 hydro-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:** Automatic transmission system expansion planning, Automatic transmission planning using interactive graphics.

4. **Distribution System Planning and Automation:** Load characteristics, Design of sub transmission 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. Sul1ivan, 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.
2. Five questions are to be attempted.

PEE: 524 Power System Communication

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

1. **Introduction:** Communication links required in telemetry, tele-control and tele protection.

2. **Analog and digital communication:** SPEd 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; PTR 1996
5. Wireless Digital Communications: K. Feher, PH I, 1995.
6. Related IEEE /IEE Publications.
7. Computer Network by Tanenbaum
8. Related IEEF/IEE Publications.

Note:

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

PEE-525 Optimization Techniques

L: 4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. **Introduction to Optimization:**
   Statement of an optimization problem, Classification of optimization problems, Optimization techniques, Engg. applications of optimization.

2. **Classical Optimization Techniques:**
   Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with in equality constraints.

3. **Linear Programming :**
   Standard form of linear programming ,Graphical solution, Simplex method, Two-phase simplex method, Computer implementation of the simplex method, Duality theory.

4. **Transportation Problem:**
   North-West Corner rule, Least cost method, Vogel approximation method, testing for optimality.

5. **Non-Linear Programming: One–dimensional minimization methods:**
   Unimodal function, Dichotomous search, Fibonacci search, Quadratic interpolation method, Cubic interpolation method .

6. **Non-Linear Programming-Unconstrained Optimization Techniques:**
   Random search method, Steepest descent method, Conjugate gradient method, Variable metric method.

7. **Non-Linear Programming - Constrained Optimization Techniques:**
   Interior Penalty function method, Exterior penalty function method.

8. **Further Topics in Optimization:**
   Critical path method (CPM), Program evaluation and review technique (PERT).

Books:-

1. S.S. Rao,Optimization : Theory and applications, Wiley Eastern Ltd.
2. G.V. Reklaitis, Engg. optimization Methods & applications, Wiley.

Note:

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

PEE-526 Neural Networks & Fuzzy Logics

L: 4	MARKS	Hrs.
Uni. Exam.	100	03
Sessional	50	

1. Neural networks characteristics, History of development in neural networks principles, artificial neural net terminology , Model of a neuron, Topology, Learning, types of learning, Supervised, Unsupervised, Re-enforcement learning. Knowledge representation and acquisition.

2. Basic Hop filed model, Basic learning laws, Unsupervised learning, Competitive learning, K-means clustering algorithm ,Kohonen's feature maps.

3. Radial basis function neural networks ,Basic learning laws in RBF nets, Recurrent back propagation, Introduction to counter propagation networks, CMAC network and ART networks.

4. Application of neural nets such as pattern recognition, Optimization, Associative memories, sPEch and decision-making. VLSI implementation of neural networks.

5. **Fuzzy Logic:** Basic concepts of fuzzy logic, Fuzzyvs. Crisp set, Linguistic variable, Membership functions, Operations of fuzzy sets, Fuzzy IF-THEN rules, Variable inference techniques, De-Fuzzification ,Basic fuzzy inference algorithm, Fuzzy system design, FKBC & PID control , Antilock Breaking system(ABS), Industrial applications.

Books Recommended:

1. Neural Networks-by Simon Haykin
2. Fuzzy logic with engineering application-by ROSS J.T(Tata Mc)
3. Neural Networks & Fuzzy Logic –by Bart Kosko
4. Neural computing theory & practice-by P.D. wasserman (ANZA PUB).
5. Introduction to applied Fuzzy Electronics-Ahmed M. Ibrahim (PHI)
6. Introduction to artificial neural systems-by J.M. Zurada.(Jaico Pub)
7. An Introduction to Fuzzy control-by D. Driankor ,H. Hellendorn, M. Reinfrank (Narosa Pub)
8. Fuzzy Neural Control-by Junhong NIE& DEREK LINKERS(PHI)
9. Related IEEE/IEE Publications.
10. Fuzzy System Design Principles, Buildidng Fuzzy IF-THEN Rule Bases-by Riza C. Berkiu & Trubatch, IEEE Press.

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.