M. Tech. Scheme &Syllabus

(Power Electronics and Drives Specialization)

W. E. F. 2012-13

Department of Electrical Engineering
National Institute of Technology, Kurukshetra

FIRST SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 561T	DC Converters & Drives	3	-	-	3	3
EE 563T	Advanced Theory of Electric Machinery	3	-	-	3	3
EE 565T	PLC & Microcontrollers	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
EE 569P	Electrical Machines & Drives Lab.	-	-	4	4	2
EE 571P	Seminar-I	-	-	2	2	2
	Total	15	-	6	21	18

Weightage for Theory Courses:
During Semester Evaluation Weightage – 50%
End Semester Examination Weightage – 50%

Weightage for Lab. Courses:
During Semester Evaluation Weightage – 60%
End Semester Examination Weightage – 40%

List of Electives (Any two electives are to be studied selecting one from each group).
Elective-I

1. EE 503T Digital Control Systems (Core in control system)
2. EE 511T Information Security (Elective with CS and PS)
3. EE 515T Control Devices (Elective with CS and PS)
4. EE 513T Reliability Engineering. (Elective with control system)
5. EE 519T Digital Signal Processing (Elective with PS and CS)

Elective-II

6. EE 505T Identification & Estimation (Core in CS, Elective in PS)
7. EE 509T Optimization Theory (Elective with CS and PS)
8. EE 517T Industrial Process Control (Elective with control system)
9. EE 531T Advanced Power System Analysis (Core in Power system)
10. EE 537T Power System Planning (Elective with PS)

NOTE:

Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

SECOND SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 562T	Modelling & Control of AC Motors	3	-	-	3	3
EE 564T	AC Converters	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
	Elective-III	3	-	-	3	3
EE 574P	Power Electronics Lab.	-	-	4	4	2
EE 576P	Seminar-II	-	-	2	2	2
	Total	15	-	6	21	18

Weightage for Theory Courses:
During Semester Evaluation Weightage – 50%
End Semester Examination Weightage – 50%

Weightage for Lab. Courses:
During Semester Evaluation Weightage – 60%
End Semester Examination Weightage – 40%

List of Electives(Any three electives are to be studied selecting one from each group).
Elective-I
1. EE 566T Computer Aided Design of Electrical Machines)
2. EE 568T Renewable Energy Resources(Elective with CS and PS)
3. EE 570T Wind Energy in Power System (Elective with CS)
4. EE 572T Energy Management (Elective with CS and PS)
5. EE 536T Advanced Power System Protection (Elective with Power system)

Elective-II
6. EE 532T Power System Operation and Control (Core in PS)
7. EE 542T High Voltage DC Transmission (Elective with Power system)
8. EE 546T Distributed generation and Control (Elective with Power system)
9. EE 502T Non-linear & Adaptive Control. (Core in Control system & Elective in PS)
10. EE 512T Embedded System (Elective with control system)

Elective-III
11. EE 534T Reactive Power Control and FACTS Devices (Core in Power System
12. EE 504T Optimal and Robust Control (Core in Control system)
13. EE 508T Intelligent Control (Elective with Control system and Power system)
14. EE 518T Virtual Instrumentation (Elective with control system)
15. EE 520T Cryptography (Elective with control system and Power system)

NOTE:
Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

THIRD SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 621P	Preparatory Work for Dissertation	0	0	20	20	10
					20	10

NOTE: The Preparatory Work for Dissertation shall be evaluated by a committee comprising the following {on the basis of one mid semester seminar and one end semester seminar presented and one end semester report submitted by the candidate}.

1. HOD or faculty nominee proposed by HOD.
2. Dissertation Supervisor (and co-supervisor).
3. Two senior most faculty members of the department.

FOURTH SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 622P	Dissertation	0	0	32	32	16
					32	16

NOTE:

I. The Dissertation shall be evaluated by a committee comprising the following through presentation cum viva-voce examination.
1..HOD or faculty nominee proposed by HOD.
2.. Dissertation Supervisor (and co-supervisor).
3.. One external expert appointed by the department.

II. For award of grade, following criteria to be used.

Grade	Conditions to be fulfilled
A+	One paper accepted/published in SCI Journal
A	One good quality paper accepted/published in non-paid journal or two good quality papers presented in International/National Conference.*
B	One good quality paper presented in International Conference
C/D	In other cases

* Conference organized by IIT/NIT/a premier R & D organization.

Non-Credit Based Dissertation Evaluation

SEMESTER-I

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-561T DC Converters and Drives

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Review of static switching devices, firing and logic circuits, starting & speed control of DC motors.
Analysis, design and control of switching regulators: Buck, Boost, Buck-Boost& Cuk, Chopper circuits & their analysis: current & voltage commutated, Jones, Type A-E choppers, AC to DC converters: Single & Multi Phase.
Performance analysis and control of Single phase and three phase DC drives, chopper control of stepper motor drive, applications of DC drives.

REFERENCES:

1. D.M. Mitchell, 'DC-DC Switching Regulator',New York: McGraw-Hill,1988.
2. M. H. Rashid, 'Power Electronics, Circuits, Devices and Applications', Prentice Hall of India Private Limited,2007.
3. P.C.Sen, 'Thyristor DC Drives', John Wiley and Sons, 1981.
4. G.K. Dubey, 'Power Semiconductor Controlled Drives', Englewood Cliffs,NJ: Prentice Hall, 1989.
5. W. Leonard, Control of Electric Drives, Germany: Springer-Verlag, 1985.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-563T **Advanced Theory of Electric Machinery**
(Core in PED Elective in PS)

L	T	P	Total	
3	0	0	3	**Credits-3**

Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Induction Machines: Analysis with nonrated voltage, nonrated frequency & unbalanced supply, De-rating/Rerating, modelling of magnetization characteristics, capacitor self-excitation of induction machines and its applications, Energy efficient motors, Air gap field space harmonics (parasitic torques, radial forces and noise), slip power recovery. Special Machines: Servomotors, stepper motors, BLDC motors. Transient theory: Analysis of Kron's primitive model, development of transformations. Transformers: Multi Circuit transformers, Parallel operation of dissimilar transformers, analysis of inrush magnetizing current.

REFERENCES:

1. L.F Blume, 'Transformer Engineering', John Wiley & Sons, Inc, New York, 1967
2. Fitzgerald & Kingsley, 'Electric Machinery' McGraw Hill Co. New Delhi, 2004.
3. A .Langsdorf, 'Theory of Alternating Current Machinery', McGraw Hill Co. New Delhi, 2004.
4. I.Boldea & S.A.Nasar, 'Induction Machine Handbook', CRC Press, New York, 2002.
5. C.M.Ong, 'Dynamic Simulation of Electric Machinery using Matlab/Simulink',Prentice Hall PTR, New Jercy, 1998.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-565T **PLC & Microcontrollers**
(Core in PED Elective in CS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

PLC and PIC Microcontroller

Logic design, Principle of Operation, Controller, Interfacing circuits, Modbus, Programming examples.

Architecture, instruction set, timer, interrupts, I/O port, interfacing A/D converter, I2Cbus operation

REFERENCES:

1. Programmable Logic controllers : Operation, interfacing and programming by Job Den Otter, PHI
2. Design with PIC Microcontrollers by John B.Peatman, Pearson

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-503T **Digital Control System.**
(Core in CS Elective in PED and PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Review of Z-transform.
Representation of discrete time systems: Pulse Transfer Functions & State Space models.
Issues of sampling and discretization.
Models of Digital control devices and systems: Z-domain description & digital filters.
Analysis of Discrete time systems, Controllability and Observability.
Stability analysis: Jury's Test, Routh's test.
Design of Digital controller: Classical & State-space techniques.
Realization of Discrete time controller, Quantization errors.

REFERENCES:

1. Digital Control Systems – by P.N. Paraskevopoulos, Prentice Hall, 1996,
2. Digital Control & State variable methods – by M. Gopal, TMH 1997.
3. Digital Control Systems by M. Gopal, McGraw Hill, 2003

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION

W.E.F. 2012-13

Course No. EE-505T **Identification & Estimation**
(Core in CS, Elective in PS and PED)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Review of probability theory; Random variables and process, stochastic processes, properties and terminology; mean, variance, correlation, spectral density, ergocity etc.
Problem formation for identification and Estimation
Models: Review of continuous and discrete, state space and input-output, disturbance models.
Identification: Impulse response and transfer function apporach (only nonparametric methods).
Parameter Estimation: Introduction.
Linear regressions and least-squares methods and properties
Prediction error approach
Non- recursive and recursive methods
Kalman filter, Extended Kalman Filter for nonlinear estimation
Maximum likelihood method
Mean square method
Convergence, computational and implementational issues
Application examples

REFERENCES:

1. Lennart Ljung. "System Identification: Theory for the user", Prentice Hall Inc, NJ 1991.
2. B.N Chatterji and K.K. Parmer, "System Identification Techniques" Oxford & IBH Pub. New Delhi. 1989.
3. A. Papoulis & S U pillai "Probability, Random Varriables and Stochastic Process" 4th edition MC Graw Hill, 2002.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-509T **Optimization Theory**
(Elective in PS, PED and CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to optimization theory , Importance in solving system engg. Problems
Convex sets & functions,supporting & separating hyperplanes, dual cones and generalized inequalities
Linear programming problem
Formulation,simplx method,two phase simplex method,dual simplex method,, Duality in linear programming,sensitivity analysis
Integer linear programming,cutting plane method, linear programming approach to game theory,dyanamic programming problems
Multi objective optimization
Intoduction to nonlinear programming
Unconstrained optimization—formulation of quadratic optimization problem,Newton raphson metmhod,gradient method
Constrained optimization—quadratic programming, saparable programming
Convex optimization problem---
Linear optimization problem, quadratic optimization problem, complexity of convex programming

REFERENCES:

1. SS Rao ,Optimization theory & applications , Wiley Eastern Ltd.
2. Convex optimization by Boyd &Vandenberghe
3. Operational research by Hamdy A.Taha

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
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Course No. EE-511T Information Security
(Elective in PS, PED and CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to Information Security and privacy, Security levels, Security aims.

System Security – Security models, Security functions and Security Mechanisms, Privacy enhancing Mechanisms, Access control: role based attribute based, Data base Security, Secure programming, Security evaluation criteria.

Network Security – Security Threats and vulnerabilities, Firewalls, IDS, Router Security, Viruses, Worms, DoS, DDos attacks, OS Security, Security protocols, Security management, Audit and Assurance, Standards, Introduction to disaster recovery and Forensics.

Indian initiatives to information security
Information Security Standards.

REFERENCES:

1. B. Matt, "Computer Security", Pearson Education., New Delhi, 2003.
2. W. Stallings, "Cryptography and Network Security", Pearson Education., New Delhi, 2003.
3. Rolf Oppliger, "Secrets technologies for world wide web", 2nd Edition, Artech House, 2003.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-513T **Reliability Engineering**
(Elective in PS,PED and CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Review of basic concepts in reliability engineering, reliability function, different reliability models etc., and reliability evaluation techniques for complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures.
Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques
Fault tree analysis
Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models.
Reliability testing
Design for reliability and maintainability
Applications of fuzzy theory and neural networks to reliability engineering
Typical reliability case studies

REFERENCES:

1. M.L Shooman, "Probabilistic reliability- an engineering approach" RE Krieger Pub, 1990.
2. K.K Aggarwal, "Reliability Engineering" Springer Pub, 1993.
3. E Balaguruswamy, "Reliability Engineering" McGraw hill, 2002.
4. R. Ramakumar, "Engineering Reliability" Prentice, NJ, 1993.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
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Course No. EE-515T **Control Devices**
(Elective in CS in PED)

L	T	P	Total	Credits-3
3	0	0	3	Duration of Exam- Three hours

During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Controllers, Transmitters, Convertors and relays, function generators,computing relays,telemetering systems,thermostat,humidistat,electronic &intelligent transmitters,fiber optic & pneumatic transmitters
Control centers& panels: annunciators and alarms,display devices & recorders
Control valves: Various types of valves
Actuators- digital and hydraulic regulators and other throttling devices,dampers, pumps as control elements ,characteristics and applications
Electric actuators :AC and DC actuating devices
Programmable logic controllers

REFERENCES:

1. Liptak, 'Process control handbook', Instrument society of America
2. C.D.Johnson,'Instrumentation systems' Prentice Hall.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-517T INDUSTRIAL PROCESS CONTROL
(Elective course in PED and CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Review of systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances, interacting and non interacting type of systems. Control valves, types, function, hydraulic, pneumatic actuators, solenoid, stepper motors.

Stability Analysis: Frequency response, design of control system, control modes, definition, characteristics and comparison of P, PI, PD, PID controllers. Dynamic behavior of feedback controlled process for different control modes, control system quality, IAE, ISE, IATE criterion, controller tuning and process identification, Zigler-Nichols and Cohen-Coon tuning methods, Bode-Nyquist Plots - Process modelling.

Special Control Techniques: Principle, analysis and application of, cascade, ratio, feed forward, override, split range, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.

Introduction to adaptive and self tuning control, distributed control systems

REFERENCES:

1. 'Process Systems analysis and Control', D.R. Coughanour, Mc.Graw Hill, II Edition, 1991.
2. 'Process Dynamics and Control', D.E.Seborg, T.F.Edger, and D.A.Millichamp, John Wiley and Sons, II Edition, 2004.
3. 'Principle and Practice of Automatic Process Control', C.A.Smith and A.B.Corripio, John Wiley and Sons, 1985.
4. 'Process control', Peter Herriot, Tata McGraw Hill.
5. 'Process Modelling Simulation and Control for Chemical Engineers', W.L.Luyben, McGraw Hill, II Edition, 1990.
6. 'Chemical Process Control – Theory and Practice', Stephanopoulous, Prentice Hall of India, Ltd.,.1984.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-519T **Digital Signal Processing**
(Elective course in PS, PED and CS)

L	T	P	Total	
3	0	0	3	**Credits-3**

Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Digital Signal Processing Applications; Filter Design, FIR & IIR Digital Filter Design, filter Design programs using MATLAB , Fourier Transform: DFT, FFT programs using MATLAB

Real Time Implementation: Implementation using DSP of (i) Digital filters (ii) & FFT applications.

Multirate DSP : The basic sample rate alteration, time – domain characterization & frequency domain characterization, Cascade equivalences, filters in sampling rate alteration systems, digital filter banks and their analysis and applications; multi level filter banks, estimations of spectra from finite – duration observation of signals.
linear prediction and optimum linear filters : forward and backward linear prediction, AR Lattice and ARMA lattice – ladder filters, Wieners filters for filtering on prediction.
Introduction to Digital Signal Processors, Architectures of TMS-320 series, Instruction Set, Programming and Interfacing

REFERENCES:

1. P.P. Vaidhyanathan, Multirate systems and filter banks, Prentice Hall, 1993.
2. Emmanuel Ifeachor and Barrie Jervis, Digital Signal Processing: A Practical Approach (2nd Edition), Prentice Hall, 2004.
3. J.G Proakis and D.G Manolakis - Digital Signal Processing: Principles, Algorithms and Applications, PHI, 2004.
4. A.V. Oppehein and R.W. Schafer, Discrete time signal processing, PHI, 1992
5. Haykins, Adaptive Filter Theory, Prentice Hall, 1986
6. Orfanidis Sophocles J, Optimum Signal Processing, McGraw Hill, 1988
7. Theory and applications of digital signal processing by Lawrence R. Rabiner and BernardGold, PHI
8. Digital Signal Processing, A Computer – Based approach, by Sanjit K. Mitra, Tata McGraw-Hill, 2008
9. Reference Manual of TMS-320 Digital Signal Processor.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-531T ADVANCED POWER SYSTEM ANALYSIS
(Core in PS elective in PED)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Bus Impedance Algorithm: Partial network, building algorithm for bus impedance matrix, Addition of links, addition of branches, (considering mutual coupling) removal of links, modification of bus impedance matrix for network changes, Formation of bus admittance matrix and modification, Gauss elimination, Node elimination (Kron reduction), LU factorization, Schemes of Ordering, Sparsity, Calculation of Z bus elements for Y bus, Numerical examples

Balanced and unbalanced network elements: Representation of three phase network elements, representation under balanced and unbalanced excitation, transformation matrices, symmetrical components, sequence impedances, unbalanced elements, three phase power invariance.

Short circuit studies: Network representations for single line to ground fault, line to line fault, LL-G fault, and 3-phase faults, network short circuit studies using Z bus, Short circuit calculations for various types of faults in matrix form, numerical examples.

Load flow studies: Load flow and its importance. classification of buses, load flow techniques, Iterative solutions and computer flow charts using Gauss-Seidel and Newton-Raphson methods, Decoupled and fast decoupled methods, representation of regulating and off nominal ratio transformers and modification of Ybus, comparison of methods, numerical examples.

Introduction to AC-DC load flow problems: formation and solutions.

Power system security: Introduction to Power system security, Adding removing multiple lines, piece-wise solution of interconnected systems, analysis of single and multiple contingencies, analysis with sensitivity factors, system reduction for contingency and fault analysis.

REFERENCES:

1. G.W. Stagg & A.H EI-Abaid, 'Computer methods in Power system analysis', McGraw Hill, New York.
2. M. A. Pai, 'Computer Techniques in Power System Analysis', 2nd Edi., TMH-New Delhi.
3. Kusic., 'Computer-Aided Power System Analysis', Prentice Hall of India, New Delhi.
4. John J.Grainger and W.D.Stevenson, 'Power System Analysis', McGraw Hill, New York, 1994.
5. A.J. Wood & W.F. Wollenberg, 'Power Generation, Operation, and Control', 2nd Edn, John Wiley & Sons, New York, 1996.
6. O.I. Elgerd, 'Electric Energy Systems Theory: An Introduction', McGraw Hill, New York, 1982.
7. J. Arrillaga, C.P Arnold & Harker, 'Computer Modeling of Electrical Power Systems', John Wiley & Sons.
8. Enrique Acha et al., 'FACTS: Modeling and Simulation in Power Networks', John Wiley and Sons Ltd., 2004.
9. Kothari and Dhillon, 'Power Systems Optimization', PHI, 2004.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-537T **Power System Planning**
(Elective in PS and PED)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

General power system planning issues, economic analysis, load forecasting, production cost modeling, generation expansion planning, substation expansion planning, network expansion planning, reactive power planning.
Power System Reliability evaluation of above aspects
Deregulation of power systems, power system planning under uncertainty, risk based power system planning.

REFERENCES:

1. "Electric Power System Planning: Issues, Algorithms and Solutions" , by Hossein Seifi, Mohammad Sadegh Sepasian, Springe –Verlag, Berlin, 2011.
2. "Economic Market Design and Planning for Electric Power Systems". By James Momoh, Lamine Mili, John Wiley and Sons, New Jersey, 2010.
3. "Electrical Power Systems Planning", by A. S. Pabla, McMillan Publishers, India, 1998.
4. "Modern Power System Planning" , Ed. by X. Wang and J. R. McDonald, McGraw Hill, London, 1994.
5. "Power System Planning", by R. Sullivan, McGraw Hill, 1977.
6. "Reliability Evaluation of Power System" Roy Billinton and Ronald Norman Allan

SEMESTER-II

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-562T **Modelling & Control Of AC Motors**
(Core in PED Elective in PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction to steady state and transient modeling of electrical machines, **R**eview of steady state modeling of induction and synchronous motors, **R**eference Frame Theory: back ground, transformations, various types of reference frames, transformation from one reference frame to other reference frame. **M**odeling of Induction and synchronous machines: voltage, flux and torque equations in arbitrary reference frame, saturation models. **C**ontrol of ac motors: speed and torque control in induction and synchronous motors.

REFERENCES:

1. "Analysis of Electric Machinery and drive systems" by Paul C. Krause Oleg Wasynczuk, Scott D.Sudhoff, John Wiley and Sons, 2004.
2. "Dynamic Simulations of Electric Machinery" by C.M.Ong, Prentice Hall Ptr, New Jersey, 1998.
3. "Generalized Theory of Electrical Machines", P.S. Bimbhra, Khanna Publishers, 2010.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-564T **A.C. Converters**

Credits-3

L T P Total	**Duration of Exam- Three hours**
3 0 0 3	**During Semester Evaluation Weight age-50%**
	End Semester Examination Weight age -50%

A.C Controllers: Single-phase and three-phase a.c. controllers. Topologies, triggering techniques for power factor and harmonic controls, Derivation of expression of output voltage, input power factor, THD using various control techniques like phase angle control, symmetrical angle control.

Cycloconverter: Concept of three-phase to single phase, single phase to single phase and single phase to three phase cyclo-converter. Constant firing angle and cosine wave crossing firing control technique. Harmonic analysis of the output voltage. Effect of source inductance.

Inverter: Series and parallel inverter, Single-phase and three-phase inverters, configuration of VSI & CSI. Concept of PWM techniques. Single Pulse, multiple pulse periodic and sinusoidal PWM technique. Multilevel inverter. Harmonic analysis of the output voltage of each type of inverter. Reduction of harmonics.

REFERENCES:

1. N. Mohan, T.M Undeland & W.P Robbin, Power Electronics, Converter Applications and design, John Wiley & Sons, 1989.
2. M.H. Rashid, Power Electronics, Prentice Hall, 1994.
3. B.K. Bose, Power Electronics and AC Drives, 1986.
4. R. Bausiere and G. Seguier, Power Electronics Converters, Springer-Verlag, 1987.
5. D.M Mitchell, DC-DC Switching Regulator Analysis, McGraw Hill, 1987.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-566T **Computer Aided Design of Electrical Machines**
(Elective in PED & PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Importance of magnetic and insulating materials, objectives & limitations of design, Review of design processes of transformer and rotating electrical machines,

Computer aided design: Advantages, limitation, analysis and synthesis methods, selection of input data, design variables and flow charts for the design of transformer and rotating electrical machines, introduction of optimization techniques, optimal design of electrical machines.

References:

1. M. Ramamoorthy,'Computer Aided Design of Electrical Equipment', East West Press, New Delhi.
2. Cyril G. Veinott,'Computer Aided Design of Electric Machinery', MIT Press, UK
3. A.K. Sawhney, 'A Course in Electrical Machine Design', DhanpatRai& Co., Delhi
4. Upadhyay K.G., 'Conventional and Computer aided design of electrical machines', Galgotia Publications, New Delhi

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-568T **Renewable Energy Resources**
(Elective in PED, PS&CS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction: types, advantages, limitations & scope of renewable energy resources. Wind energy: basic principles & energy conversion schemes, major components, electrical generators used & their analysis.

Solar Energy: Basic Principles & Energy Conversion Schemes.

Hydro power: site selection, types of power stations, major components & their working. Biomass energy: biogas generation, types of biogas plants.

Geothermal energy: Origin and nature of geothermal energy; classification of geothermal resources; schematic of geothermal power plants.

Ocean energy: wave energy conversion devices, advantages and disadvantages of wave energy, basic principles of tidal energy, tidal power generation systems.

References:

1. 'Renewable energy – power for sustainable future'.Edited by Godfrey Boyle.Oxford University Press, 2010.
2. 'Renewable energy sources and their environmental impact'.S.A.Abbasi and NaseemaAbbasi.Prentice-Hall of India, 2010.
3. 'Non-conventional sources of energy'. G.D. Rai. Khanna Publishers, 2000.
4. 'Renewable energy sources and emerging technologies' D.P.Kothari, K.C.Singal andRakeshRanjan, PHI Publishers, 2009.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-570T **Wind Energy in Power System**
(Elective in PED, PS & CS)

L	T	P	Total	Credits-3
3	0	0	3	Duration of Exam- Three hours

During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction: Historical developments and current status of wind power, Energy and power in wind, Wind energy conversion system, basic integration issues related to wind power.
Wind Turbines: Technological developments, Types, Aerodynamics of wind turbines.
Variable Speed Generators: Construction and working of asynchronous & permanent magnet synchronous generators, steady state performance, exponential modeling of magnetization curve, d-q axis modeling of induction and permanent magnet generators.
Static Control: Control modeling, various control schemes for cage and wound rotor induction generators.
Impact of Power Generation: regulatory framework, impact of constant and variable speed wind turbines on transient stability of power system, effects of switching capacitors and other operations of wind farms on power quality, wind system economic components, economic analysis methods.

References:

1. 'Wind power in power system', edited by Thomas Ackermann, John Wiley & Sons Ltd., 2005.
2. 'Variable Speed Generators', Ion Boldea, CRC Press, 2006.
3. 'Renewable energy – Power for Sustainable Future'.Edited by Godfrey Boyle.Oxford University Press, 2010.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-572T **Energy Management**
(Elective in PED,PS &CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage-50%
End Semester Examination Weightage- 50%

Introduction, need of energy management, importance of energy audit and its types, financial analysis techniques, energy monitoring and targeting.
Energy efficiency control of boilers, furnaces, cogeneration, HVAC, cooler tower and lighting systems.
Energy demand analysis and forecast: energy data management, energy demand analysis, energy control and forecast methods.
Energy management of drive systems: industrial systems, measurements, performance estimation, energy efficient motors, planning and saving analysis.
Intelligent buildings: energy saving opportunities, measurement and control.
Smart grid and its role in energy management.

References:

1. "Energy Management Principles, Applications, Benefits, Savings", Craig B. Smith, Peragamon Press, New York, 1981.
2. "Energy Management of Drive System", Office of Industrial Technology, Energy Efficiency and Renewable Energy, US Department of Energy.
3. "Energy Management Systems", Edited by P. GiridharKini,InTech, Publication, 2011.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-532T **Power System Operation and Control**
(CORE IN PS, ELECTIVE IN CS & PED)

Credits-3

L	**T**	**P**	**Total**
3	**0**	**0**	**3**

Duration of Exam- Three hours
During Semester Evaluation Weight age-50%
End Semester Examination Weight age - 50%

Characteristics of power generation units, Economic dispatch of thermal units, security constrained economic dispatch, hydrothermal coordination.
Optimal power flow and its applications, Reactive power optimization, Unit commitment.
Automatic generation control- Single area and Multi-area.
Power system security, contingency analysis, state estimation, optimal load shedding.

REFERENCES:
:

1. A. J. Wood and B. F. Wollenberg, Power Generation Operation and Control, Wiley.
2. O. I. Elgerd, Electric Energy Systems Theory: An Introduction, TMH.
3. Jizhong Zhu, Optimization of Power System Operation, IEEE – Wiley.
4. R. H. Miller, J. H. Maliwski, Power System Operation, TMH.
5. James Momoh, Electric Power System Application of Optimization, CRC Press.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13
REACTIVE POWER CONTROL AND FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) DEVICES
(CORE IN PS, ELECTIVE IN CS & PED)

Course No. EE-534T **Credits-3**
L T P Total **Duration of Exam- Three hours**
3 0 0 3 **During Semester Evaluation Weight age – 50%**
End Semester Examination Weight age - 50%

Reactive Power Control in Electric Transmission Systems, Loading Capability and Stability Considerations, Introduction to related concepts and systems requirements.

Flexible AC Transmission Systems (FACTS) Devices: Configuration of FACTS devices, Principles of operation and control techniques.

Application of FACT devices in: Power System Satiability analysis, Reactive power control, Optimal power flow analysis, Wide area monitoring.

References:

1. Understanding FACTS: NG Hingorani, J Gyugi (JEEE Press)
2. Flexible AC Transmission Systems (FACTS), Y.H. Song (JEEE Series)
3. Thyristor Based FACTS Controller for Electric Transmission systems- R Mathur & PK Verma, IEEE Press (Wiley)
4. Reactive Power Control in Power Systems TJE Miller (Johan Wiley and Sons)
5. Reactive Power Control and Voltage stability in Power Transmission Systems, , Abhijit Chakrabarti, D P Kothari, AK Mukhopadhyay, Abhinandan De, (PHI)
6. Flexible AC Transmission: Modelling and Control, X-P. Zhang, C.Rehtanz, B.Pal, (Springer)

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-536T **Advanced Power System Protection**
(Elective in PED & PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction: Need for protective systems, nature of fault & statistics, Zones of protection, local & remote back up, classification or protective relays and protective schemes, comparison of conventional relays with modern relays, salient features of current transformers and potential transformers for protection purpose. Static Relays: Over current relays, differential relays, distance relays, impedance relays. Comparators: general equation of comparators, Analysis for amplitude comparator, analysis for phase comparator, duality between amplitude and phase comparators, different types of amplitude and phase comparators.Distance protection: time grading of distance relays, schemes of distance protection, Effect of arc resistance and power swings, selection criterion for distance relays, pilot wire protection, carrier current protection. Analysis of protection schemes for Generators, transformers and motors.Microprocessor based protective relays: Over current relay, impedance relay, directional relay, reactance and mho relay.

REFERENCES:

1. T.S. MadhavaRao, "Power System Protection – Static Relays", Tata McGraw Hill, REPRINT 2008.
2. B. Ravindernath and M. Chander, "Power System Protection and Switchgear", New Age International Ltd, 2005.
3. Badri Ram and Vishwakarma, Power System Protection and Switchgear, TATA McGraw Hill,2007.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-542T **H V D C Transmission**
(Elective in PS &PED)

Credits-3

L T P Total	**Duration of Exam- Three hours**
3 0 0 3	**During Semester Evaluation Weight age-50%**
	End Semester Examination Weight age - 50%

Introduction: Comparison of AC and DC transmission, Application of DC transmission, Planning of HVDC transmission.
Graetz Circuit, Analysis of Twelve-pulse converter.

HVDC System control: Principles of Dc link control, Converter control characteristics, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control.

Reactive Power Control: Sources of reactive power, Static VAR systems, Reactive power control during transients.

Harmonics and Filters: GENERATION Of harmonics, Methods of Harmonics reduction, AC and DC filters used for Harmonic Elimination.

Converter Fault and protection: Converter faults, Protection against over currents and over voltages.

References:

1. EW Kimbark,'Direct current Transmission,' Vol. I, Wiley Interscience.
2. J. Arrillaga,' High Voltage Direct Current Transmission', Peter Peregrines.
3. KR Padiyar,'HVDC Power Transmission Systems', New Age International (P) Ltd., Publishers, 3rd Edition.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-546T DISTRIBUTEED GENERATION AND CONTROL
(ELECTIVE IN PS & PED)

Credits-3

L	**T**	**P**	**Total**
3	**0**	**0**	**3**

Duration of Exam- Three hours
During Semester Evaluation Weight age-50%
End Semester Examination Weight age - 50%

Need, Advantages & features of distributed generators, Overview of energy sources relevant to Distributed generation.

Isolated generation and Energy storage for Distributed Generation: Wind- diesel systems- fuel savings- permanent magnet alternators- modeling- steady state equivalent circuit- self excited induction generators- integrated wind- solar systems, battery energy storage, SMES, capacitor and other energy storage systems.

Gas turbine powered Distributed generators and other Renewable Sources: Gas turbine types, mini and micro gas turbine generators, micro- hydel electric systems- power potential- scheme layout- generation efficiency and turbine power flow, isolated and parallel operation of generators- tidal and other sources and applications.

REFERENCES:

1. John F. Walker & Jenkins, N., "Wind Energy Technology," John Wiley and sons, Chichester, U.K., 1997.
2. Van Overstraeton R. J and Mertens R P., "Physics, Technology and use of photovoltaic", Adem Hilger, Bristol, 1996.
3. Sukhatme, S.P.,"Solar energy- Principles of Thermal Collection and Storage" Tata McGraw-Hill, New Delhi.
4. S.L Soo," Direct Energy Conversion", Prentice Hall Publication.
5. Freries L.L, 'Wind Energy Conversion systems', Prentice Hall U.K., 1990.
6. Kreith, F., and Kreider, J.F,'Principles of Solar Engineering', Mc- Graw- Hill, Book Co.
7. Imamura M. S.et.al, 'Photo voltaic system technology, European hand Book', H.S., Stephen and Associate, 1992.
8. James Larminie, Andrew Dicks, FUEL Cell Systems', John Wiley and Sons Ltd.
9. Chapman and E.J. Womack. 'MHD Power Generation Engineering Aspects', Hall Publication.
10. H. Lee Willis and W.G. Scott, 'Distributed Power Generation', Marcel Dekker, Inc. 2000.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F 2012-2013

Course No. EE-502T **Non-Linear and Adaptive Control**.
(Core in CS & Elective in PED,PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction to nonlinear systems and their behavior.
Analysis of nonlinear systems using perturbation theory, phase plane trajectories, Describing functions, Lyapunov& Pupov's methods.

Nonlinear control design techniques; Feedback linearization, input-state and input-output linearization, design issues for MIMO nonlinear systems.
Variable structure control, sliding surface design, approximation of switching laws.
Adaptive control:
Need for adaptive control, MIT rule, Model reference and self tuning adaptive control techniques, Auto tuning, Gain scheduling.
Stability, convergence and robustness issues in adaptive control.
Adaptive control of nonlinear systems.
Practical aspects, implementation and applications of adaptive control.

References:

1. Slotine J.J.E and W. Li, "Applied nonlinear control", Prentice Hall Inc., 1991.
2. Mohler R.R., "Nonlinear systems: Dynamics and Control", Prentice Hall Inc., 1991.
3. M. Vidyasagar, "Nonlinear system analysis", Prentice Hall, 1993
4. K.J. Astrom "Adaptive Control", Addison Wesley.
5. Astrom K.J. and B. Wittenmark, "Computer Controlled Systems: Theory and Design", Prentice Hall of India, 1994.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION

W.E.F 2012-2013

Course No. EE 504T **Optimal and Robust Control**
(Core in CS &Elective in PED)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Variational approach to optimal control

Algebraic Riccati equation, Riccati operator and stabilizing solutions, Extreme solutions.

Linear quadratic regulator, return difference inequality and robustness margins, cross product terms, output feedback, Linear quadratic trackers, LQG control and separation principle, simple applications.

Systematic formulation of robust control problem, Uncertainty and robustness, Effect on system stability and performance, Performance limitations.
Review of measures of signals and systems, H2 and H ∞ norm computations. Linear fractional transformations, Parameterization of stabilizing controllers.

Solutions to general H2 and H∞ control problems, H∞ loop shaping, Variable structure control.

References:

1. F.L. Lewis and V.L. Syrmos, "Optimal Control", John Wiley & Sons, NY 1995
2. K. Zhou, J.C. Doyle and K. Glover, "Robust & Optimal Control", Prentice Hall Inc. NY 1998.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F 2012-2013

Course No. EE 508T **Intelligent Control**
(Elective in PED,PS &CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to Intelligent Control, Soft Computing Methodologies – Artificial Neural Networks, Fuzzy Logic, Genetic Algorithm. Need for intelligent control, Introduction to intelligent system modeling using ANN and Fuzzy logic.

Basic Fuzzy Logic System, Fuzzy Logic based system modeling, Fuzzy Logic based Controller Design. Theoretical and implementation issues.

Artificial Neural Networks, types of ANN architectures, ANN learning techniques, ANN based system modeling, ANN based controller design, theoretical and implementation issues.

Introduction to neurofuzzy systems and their application to control of complex systems.

References:

1. Fuzzy Logic Control by T.J. Ross TM.H. Publications.
2. Fuzzy Logic Control by Drinnkov, Narosa Publishers.
3. Comprehensive Neural Networks by Simon Hekins, Pearson Publications.
4. Neuro Fuzzy and Soft Computing by J.S.R. Jang, C.T. Sun, E. Mizutani, P.H.I. Publishers.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-510T **Embedded Systems**
(Elective in PED &CS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Components of Embedded Systems, Embedded Processors, Memory Systems, Peripherals, Interfacing, Real Time Operating Systems (RTOS).

Embedded System Software, Concept of Co Design, Wireless Embedded Systems, Performance Issues, Embedded Control Applications, Case Studies.

References:

1. Embedded Systems Design-2nd Edition New Delhi: Newnes 2008,Heath Steve.
2. Embedded System: World Class Design-London: Elsevier 2008-Ganssle,Jack.
3. Embedded System Design: A Unified Hardware/Software Introduction- New York:2003-Vahid,Frank.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE-516T **Virtual Instrumentation**
(Elective in PED,PS &CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data flow techniques, graphical programming in data flow, comparison with conventional programming. Development of virtual instrument using GUI, real time systems.

VI Programming Techniques: VIS and sub VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, instrument drivers, publishing measurement data in web.

Data Acquisition basics: Introduction to data acquisition in PC, sampling fundamentals, input/output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA,Software and Hardware installation,calibration,Resolution,Data acquisition interface requirement

LabView hardware: VI Chassis requirement,common instrument interface:current loop,RS232C/RS485,GPIB.Bus interfaces,GPIB,PCI Card.

VI toolsets and application of Virtual Instrumentation

References:

1. Gary Johnson,LABVIEW graphical programming,Second edition,mcgraw hill,NY,1997.
2. Lisa K.Wells&Jeffrey travis,Labview for every one,Prentice Hall,new jersey,1997.
3. Virtual Instrumentation using labview by Sanjay Gupta and Joseph John,(TMH)
4. LAB VIEW Advanced Programming Techniques2nd edition by Rick Bitter,Taqi mohd,Mah Nawrock(CRC Press)
5. Kevin James,PC Interfacing and data acquisition: Techniques for measurement, Instumentationand Control,newness,2000.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER ELECTRONICS & DRIVES SPECIALIZATION
W.E.F. 2012-13

Course No. EE518T **Cryptography**
(Elective in PED,PS &CS)

L	**T**	**P**	**Total**	
3	**0**	**0**	**3**	**Credits-3**
				Duration of Exam- Three hours
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction to Cryptography and information Security
Mathematical Foundation
Introduction to groups, rings and fields, Congruences and residue classes, quadratic residues and square roots modulo integer. Theory of computational complexity, fundamentals of probability theory.

Basic Cryptographic techniques – Classical techniques, Symmetric techniques (AES & DES), Asymmetric techniques – Discrete log problem, Deffie Hellman Key exchange, RSA algorithm.

Message authentications, Cryptographic Hash Functions, Hash algorithms,Digital Signatures and authentication.

References:-

1. W. Stallings, "Cryptography and Network Security", Pearson Education., New Delhi, 2003.
2. W. Mao, "Modern Cryptography: Theory and practice", Pearson Education., New Delhi, 2004