

COURSE STRUCTURE FOR M.TECH. ELECTRICAL ENGINEERING SEMESTER I

w.e.f. 2013-2014

Sr. No	Course Code	Course Name	Teaching Scheme					Exam Scheme					Total Marks
			L	T	P	C	Hrs/wk	Theory			Practical		
								MS	ES	IA	LW	LE/Viva	
1	MA 503T	Advanced Numerical Techniques and Computer Programming	3	0	0	6	3	30	60	10	--	--	100
2	EE 501	Advanced Electrical Machines	3	0	0	6	3	30	60	10	--	--	100
3	EE 502	Advanced Power System Protection	3	0	0	6	3	30	60	10	--	--	100
4	EE 503	Modern Processors and Embedded Systems	3	0	0	6	3	30	60	10			100
5	EE 5xx	Department Elective	3	0	0	6	3	30	60	10	--	--	100
6	EE 506	Laboratory-I	0	0	4	2	4	--	--	--	50	50	100
		Total	15	0	4	32	19	150	300	50	50	50	600

IA = Internal assessment (like quiz, assignments etc)

MS = Mid Semester, ES = End Semester;

LW = Laboratory work; LE = Laboratory Exam

Department Electives:

1. EE 504 Finite Element Methods
2. EE 505 Renewable Energy Systems

EE 501 Advanced Electrical Machines										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
UNIT I										10
<p>INDUCTION GENERATORS: self excitation requirements, steady state analysis, voltage regulation, different methods of voltage control, application to mini and micro hydro systems.</p> <p>DOUBLY FED INDUCTION MACHINES: control via static converter, power flow, voltage/frequency control (generation mode), application to grid connected wind and mini/micro hydro systems.</p> <p>HIGH PERFORMANCE ENERGY EFFICIENT MACHINES: Technology of energy efficient motors, selection and application of energy efficient motors.</p>										
UNIT II										08
<p>SWITCHED RELUCTANCE MOTOR: Construction, operating performance, control and applications.</p>										
UNIT III										12
<p>BRUSHLESS DC MACHINES: construction operation, performance, control and applications.</p> <p>LINEAR MACHINES: Linear Induction Machines and Linear Synchronous Machines. Construction, operation, performance, control and applications.</p>										
UNIT IV										09
<p>PERMANENT MAGNET MATERIALS : Properties of different Permanent Magnet materials, B-H loop and demagnetization characteristics, temperature effects, mechanical properties, applications</p> <p>APPLICATION OF PERMANENT MAGNETS IN ELECTRICAL MACHINE: structure, magnetic materials used, types of motors e.g. PMDC and PM Synchronous Machine, control and applications.</p> <p>RECENT DEVELOPMENTS IN ELECTRICAL MACHINES</p>										
										TOTAL HOURS 39
Texts and References:										
<ol style="list-style-type: none"> 1 T. J. E. Miller, "<i>Brushless PM and Reluctance Motor Drives</i>", Clarendon Press Oxford 2 R. Krishnan, "<i>Electric Motor Drives</i>", PHI 3 Jacek Gierasewing, "<i>P. M. motor technology</i>", Marcel Dekker 4 Denis O'Kelly, "<i>Performance and Control of Electrical Machines</i>", McGraw-Hill, 1991 5 P. C. Sen, "<i>Principles of Electrical Machines and Power Electronics</i>", Wiley, 1989 6 Web-Resources : http://www.beeindia.in/ 7 Howard E. Jordan, "<i>Energy Efficient Electric Motors & Their Applications</i>", Springer, 1994 										

EE 502 Advanced Power System Protection										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
UNIT I										09
<p>PROTECTIVE RELAYING FUNDAMENTALS: General Background, Zones of Protection, Requirements of Protection System, Unit and Non-unit Protection, Primary and Back-up Protection, Historical Development of protection, Classification of Protective Relays, Electro-mechanical (Electromagnetic) Relays(Thermal relay(Electromagnetic) Relays, Attracted Armature Relay, Induction Relays, Induction Disc Relay, Induction Cup Relay, Balance Beam Relay, Universal Torque Equation), Solid State Relays (Introduction, Comparison between Static and Electromechanical Relays, Classification of Static Relays, Generalized Static Time-Over current Relays), Digital Relaying(Merits and Demerits of Digital Relay, Generalized Block Diagram of Digital Relay, Sampling and Data Window), Tripping Mechanism of Relay, Different Relay Algorithms(Algorithms assuming pure sinusoidal relaying signal, Algorithms based on solution of system differential equations, Algorithms Applicable to Distorted Relaying Signals), Concept of Adaptive Relaying</p>										
UNIT II										10
<p>PROTECTION OF TRANSMISSION LINES: Introduction, Various Types of Transmission Line Faults, Overview of Over Current Protection of Transmission Lines, Over View of directional Protection Relay, Modern Digital/Numerical Over current & Earth Fault Relay, Over Current Relay Coordination in an Interconnected Power System(Introduction, LINKNET Structure, Determination of Primary/Back-Up Relay Pairs)</p> <p>DISTANCE RELAYING: Introduction, Transmission Line Protection, Distance Protection, Reach of Distance Relay, Selection of Measuring Unit, current and Voltage Connections, Problems & Remedies in Distance Protection(Close-in fault, Fault Resistance, Remote In-feed, Mutual Coupling, Series Compensated Transmission Lines, Power Swing, Overload, Transient Condition), Examples on Setting of Distance Protection, Symmetrical Component Based Distance Relay, Digital Distance Relaying Scheme</p> <p>PILOT RELAYING SCHEMES FOR TRANSMISSION LINE: Introduction to Pilot Protection System, Circulating Current Based Wire Plot Relaying Scheme, Carrier Current Protection Scheme(Phase Comparison Scheme, Directional Comparison Scheme, Blocking and Unblocking Carrier aided Distance Scheme, Carrier Blocking Scheme, Carrier Unblocking Scheme, Transfer Tripping Carrier aided Distance Scheme, Under Reach Transfer Tripping Scheme, Over Reach Transfer Tripping Scheme)</p>										
UNIT III										10
<p>PROTECTION AGAINST TRANSIENTS AND SURGES: Introduction, Sources of Transients or Surges in EHV Line, Switching of Transmission Line, Switching of Capacitor Bank, Switching of Coupling Capacitor Voltage Transformer (CCVT), Switching of Reactor, Arcing Ground, Lightning Strokes, Overvoltage Phenomenon due to Lightning and Switching, Surges and Travelling Waves, Wave</p>										

Propagation on Transmission Line, Reflection and Attenuation, Reflection, Attenuation of Transients, Attenuation of Transients Using Filter, Attenuation of Transients Using Isolation Transformer, Neutral Grounding, effects of Ungrounded Neutral on System Performance Methods of Neutral Grounding, Solid Grounding, Resistance Grounding, Reactance Grounding, Resonant Grounding, Grounding Practices, Protection against Transients and Surges, Protection against Lightning, Earthing Screen (Overhead Shielding), Overhead Ground Wires, Surge Modifier or Absorber, Lightning Arrester (Surge Diverter), Types of Lightning Arresters, Rod Gap Arrester, Horn Gap Arrester, Multi Gap Arrester, Expulsion Type Arrester, Valve Type Arrester, Silicon Carbide (SiC) Lightning Arrester, Metal Oxide (MO) Lightning Arrester, Selection Procedure for Lightning/Surge Arresters, Common Ratings of Lightning/Surge Arresters

UNIT IV

10

AUTORECLOSING AND SYNCHRONIZING & SYSTEM RESPONSE TO SEVERE UPSETS:

Introduction, History of autoreclosing, Advantages of Autoreclosing, Classification of autoreclosing Relay, Autoreclosing based on number of phases, Autoreclosing based on number of attempts, Autoreclosing based on speed, Sequence of Events of a Typical Single-shot Autoreclosing Scheme, Factors to be considered during Reclosing(Choice of zone in case of distance relay, Dead time/Deionizing time, Reclaim Time, Instantaneous Lock out, Intermediate Lock Out, Breaker supervision function), Synchronism Check(Phasing Voltage Method, Angular Method, Automatic Synchronizing)

SYSTEM RESPONSE TO SEVERE UPSETS: Introduction, Nature of system response to severe upsets, System Response to Islanding Conditions (Undergenerated Islands, Overgenerated Islands, Reactive Power Balance, Power Plant Auxiliaries, Power System Restoration), Load Shedding, Factors to be considered for Load Shedding Scheme(Maximum Anticipated Overload, Number of Load Shedding Steps, Size of Load Shed at Each Step, Frequency Setting, Time Delay), Rate of Frequency Decline, Frequency Relays, Islanding(Issues with Islanding, Methods of Islanding Detection)

TOTAL HOURS 39

Texts and References:

- 1 Stanley H. Horowitz and Arun G . Phadke, "**Power System Relaying**", Research Studies Press Ltd, 3rd Edition, 2008
- 2 Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, "**Protection and Switchgear**", Oxford Press, 2011
- 3 B. A. Oza, Date, Nair and Makwana, "**Power System Protection and Switchgear**", Tata McGraw Hill, 2010
- 4 Walter A. Elmore, "**Protective Relaying Theory and Application**", Marcel DEXXER INC, New York
- 5 J. J. Blackburn, "**Protective Relaying Fundamentals**", John Wiley and Sons

EE 503 Modern Processors and Embedded Systems										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
UNIT I										10
Introduction to Embedded Systems: Typical Embedded System, Introductions to architectures of various microcontrollers and microprocessors, Characteristics and Quality Attributes of Embedded Systems.										
UNIT II										10
ARM 9 Processors: Architecture of Arm 9 Embedded Processors, Instruction Set, Thumb Instruction Set Extension, Programming of 32 Bit ARM 9 Processor.										
UNIT III										09
Interfaces: Memory and I/O, Communication Interfaces like I2C BUS, CAN BUS, SPI BUS, UART, 1-Wire etc In Embedded Systems.										
UNIT IV										10
Real-Time Operating Systems: Real-Time Operating System based Embedded System Design. Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task synchronization.										
TOTAL HOURS										39
Text and References:										
1	Shibu K V, <i>"Introduction to Embedded Systems"</i> , McGraw-Hill									
2	Raj Kamal, <i>"Microcontrollers, Architecture, Programming, Interfacing and System Design"</i> , 2 nd Edition, Pearson									
3	Lyla B. Das, <i>"Embedded Systems-An integrated approach"</i> , Pearson									
4	Raj Kamal, <i>"Embedded Systems, Architecture, Programming and Design"</i> , 2 nd Edition, McGraw-Hill									
5	Arnold S Burger, <i>"Embedded system design"</i> , CMP books, 2010									
6	David Simon, <i>"An embedded software primer"</i> , PEA, 2008									
7	Internet References									
	www.arm.com									

EE 507 Modern Control Systems										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
UNIT I										11
ANALYSIS OF CONTROL SYSTEMS IN STATE SPACE: Concept of state and state space, state and output equations, state variable representations, canonical realizations, solution of state equations, Concepts of controllability and observability.										
UNIT II										11
STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS: Discretisation of continuous time state equation, discrete time state equations, solution of discrete state space equations, Controllability to the origin and reachability.										
UNIT III										17
DESIGN OF MODERN CONTROL SYSTEMS: Pole placement design through state feedback, stability improvement by state feedback, state regulator design, Design of state observer and state estimator, Quadratic optimal regulator design, Model predictive control design.										
TOTAL HOURS										39
Text and References:										
1 C.T.Chen, " <i>Linear system theory and design</i> ", Oxford, 3 rd Edition, 1999										
2 K. Ogata, " <i>Modern Control Engineering</i> ", PHI, 4 th Edition, 2006										
3 M. Gopal, " <i>Digital Control and State Variable Methods</i> ", TMH, 3 rd Edition, 2009										
4 John Bay, " <i>Fundamentals of linear state space systems</i> ", McGraw Hill, 1998										
5 Wilson Rugh, " <i>Linear system theory</i> ", Prentice Hall, 2 nd edition, 1996										
6 Thomas Kailath, "Linear systems", Prentice Hall International										
7 B.C.Kuo, "Automatic Control System".										

Department Elective

EE505 RENEWABLE ENERGY SYSTEMS										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
UNIT I 10 INTRODUCTION: World energy use, Reserves of energy resources, Environmental aspects of energy utilization, Renewable energy scenario in India, Potentials, Achievements, Applications, Concept of energy conservations.										
UNIT II 10 SOLAR ENERGY: Solar radiation, Solar radiation spectrum, Solar constant, Extra terrestrial radiation, Geometrical parameters – Longitude, Latitude and Altitude angles, Solar angles- solar azimuth angle, surface azimuth angle, air mass, incidence angle, slope. Solar thermal applications, Flat plate and concentrating collectors, Solar heating and cooling techniques, Solar desalination, Solar Pond, Solar cooker, Solar thermal power plant, Solar photo voltaic conversion, Solar cells, PV applications, Blocking diode, Bypass diode										
UNIT III 09 WIND ENERGY: Wind data and energy estimation, Betz limit, Basic components of wind electric system, Types of Wind energy conversion devices (Dutch windmills, Mutli-bladed water pumping windmills, High speed propeller type wind machines), Principle of Lift and Drag force on aerofoil (Basics of Aerodynamics), Design of Wind turbine rotor, Power Speed Characteristics, Power torque characteristics, Concept of Savonius and Darrious rotors, Types of wind energy systems, Performance and calculations, Details of wind turbine generator, Comparison of Wind generators, Wind turbine control system (pitch, stall and yaw controls).										
UNIT IV 10 BIOMASS ENERGY: Biomass direct combustion, Biomass gasifier, Biogas plant, Ethanol production, Bio diesel, Cogeneration, Biomass applications OTHER RENEWABLE ENERGY SOURCES: Tidal energy, Wave energy, Open and closed OTEC Cycles, Small hydro, Geothermal energy, Fuel cell systems										
TOTAL HOURS 39										
Text and References:										
1 G.D. Rai, “Non Conventional Energy Sources” , Khanna Publishers, New Delhi, 1999.										
2 S.P. Sukhatme, “Solar Energy” , Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.										
3 Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future” , Oxford University Press, U.K, 1996.										
4 Twidell, J.W. & Weir, A., “Renewable Energy Sources” , EFN Spon Ltd., UK, 1986.										
5 G.N. Tiwari, “Solar Energy, Fundamentals Design, Modelling and applications” , Narosa Publishing House, New Delhi, 2002.										
6 L.L. Freris, “Wind Energy Conversion systems” , Prentice Hall, UK, 1990.										
7 Johnson Gary, L., “Wind Energy Systems” , Prentice Hall, New York, 1985.										