### COURSE STRUCTURE FOR M.TECH. ELECTRICAL ENGINEERING

#### SEMESTER I

w.e.f. 2013-2014

<table>
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<tr>
<th>Sr. No</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
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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

March-April 2014
### EE 501 Advanced Electrical Machines

#### Teaching Scheme

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**UNIT I**

**INDUCTION GENERATORS:** self excitation requirements, steady state analysis, voltage regulation, different methods of voltage control, application to mini and micro hydro systems.

**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.

**HIGH PERFORMANCE ENERGY EFFICIENT MACHINES:** Technology of energy efficient motors, selection and application of energy efficient motors.

**UNIT II**

**SWITCHED RELUCTANCE MOTOR:** Construction, operating performance, control and applications.

**UNIT III**

**BRUSHLESS DC MACHINES:** construction operation, performance, control and applications.

**LINEAR MACHINES:** Linear Induction Machines and Linear Synchronous Machines. Construction, operation, performance, control and applications.

**UNIT IV**

**PERMANENT MAGNET MATERIALS:** Properties of different Permanent Magnet materials, B-H loop and demagnetization characteristics, temperature effects, mechanical properties, applications

**APPLICATION OF PERMANENT MAGNETS IN ELECTRICAL MACHINE:** structure, magnetic materials used, types of motors e.g. PMDC and PM Synchronous Machine, control and applications.

**RECENT DEVELOPMENTS IN ELECTRICAL MACHINES**

**TOTAL HOURS** 39

#### Texts and References:

3. Jacek Gierasewing, *P. M. motor technology*, Marcel Dekker
## EE 502 Advanced Power System Protection

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### UNIT I


### UNIT II


**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

**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)

### UNIT III

**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

UNIT IV

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)

Texts and References:
5. J. J. Blackburn, “Protective Relaying Fundamentals”, John Wiley and Sons
## EE 503 Modern Processors and Embedded Systems

### Teaching Scheme

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### Examination Scheme

**UNIT I**

**Introduction to Embedded Systems:** Typical Embedded System, Introductions to architectures of various microcontrollers and microprocessors, Characteristics and Quality Attributes of Embedded Systems.

**UNIT II**

**ARM 9 Processors:** Architecture of Arm 9 Embedded Processors, Instruction Set, Thumb Instruction Set Extension, Programming of 32 Bit ARM 9 Processor.

**UNIT III**

**Interfaces:** Memory and I/O, Communication Interfaces like I2C BUS, CAN BUS, SPI BUS, UART, 1-Wire etc In Embedded Systems.

**UNIT IV**


**TOTAL HOURS** 39

### Text and References:

7. *Internet References*
   - www.arm.com
## EE 507 Modern Control Systems

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**UNIT I**

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**

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**

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:

7. B.C.Kuo, "Automatic Control System".
Department Elective
**EE505 RENEWABLE ENERGY SYSTEMS**

### Teaching Scheme

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### Examination Scheme

**UNIT I**
**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**

**UNIT III**
**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**
**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:


March-April 2014