SCHEME OF COURSE WORK

Course Details:

Course Title	**:DISTRIBUTED GENERATION**		
Course Code	**:13EE2115**	**L T P C**	**: 4 0 0 3**
Program:	**: M.Tech.**		
Specialization:	**: Power Systems Control & Automation**		
Semester	**: I**		
Prerequisites	**:Electrical Machines, Power Systems**		
Courses to which it is a prerequisite	**: Renewable Energy Sources**		

Course Outcomes (COs):

After completion of the course student acquire knowledge in

1	Classify various methods of power generation, goals of distributed generation and differentiate between stand-alone photo voltaic powers..
2	Describe the operation, performance, operational limitations,Temperature limits, and other aspects of Wind Turbine andFuel cells.
3	Describe sitting requirements, restrictions, and operationallimitations of microturbines.
4	Describe inter connected generation systems.
5	Analyze the size of Solar Photo Voltaic Systems, Wind PowerSystems, Fuel Cells and Micro Turbines, Engine – Generators.

Program Outcomes (POs):

A graduate of Power System Control & Automation will be able to

1	Acquire in depth knowledge in the area of power system control and automation.
2	Analyze the models with respect to any kind of problem on hand and try to solve related to power system control and automation.
3	Develop the capability of problem solving and original thinking to arrive at feasible and optimal solutions considering societal and environmental factors.
4	Interpret and demonstrate sufficient knowledge base, to apply the techniques and tools either individually or in groups to solve power system problems.
5	Select state-of-the-art tools for modeling, simulation and analysis of problems related to power systems.
6	Recognize positively any collaborative and multidisciplinary research to achieve common goals.
7	Demonstrate knowledge and understanding of power system engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors.
8	Communicate confidently, make effective presentations and write good reports to engineering community and society.
9	Recognize the need for life-long learning and have the ability to do it independently.
10	Understand Social responsibilities and follow ethical practices to contribute to the community for sustainable development.
11	Predict and self examine critically the outcomes of actions, reflect on to make corrective measures and move forward positively.

Course Outcome Versus**Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S			M	M		S				
CO-2	M			M	M		S				
CO-3				M	M		S				
CO-4	S	M	S	M	M		S				
CO-5				M			S				

S - Strongly correlated, *M* - *Moderately* correlated, *Blank* - *No correlation*

AssessmentMethods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	Introduction, Distributed Generation Technologies, Solar Photo Voltaic Power, Wind Power, Fuel Cells, Micro Turbines, Engine Generators, Passive Vs Active Generation	CO-1	Explain the different types of distributed generation technologies?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 1)
2	Goals of Distributed Generation, Reducing the Electric Utility Bill, Improving System Reliability, Standby systems, Selling Power, Generating Environmentally Friendly power, Electrical Utility companies and Distributed Generation.	CO-1	Explain the goals of distributed generation technologies?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 2)
3	Introduction, Components, Foundation and Supports, Fixed Arrays, Tracking Arrays, Solar Arrays, Utility Interactive Power Inverter, Operation , Tilting angle of the array	CO-1	What is an array? Explain different types of arrays?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 3)
4	, Stand Alone Photo Voltaic Power, Grid Connected Photo Voltaic Power, Photo Voltaic Module Ratings, Voltage Ratings, Current Rating, Power Rating, Maximum	CO-1	Mention the ratings of solar power system?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 4)

	Open Circuit Voltage, Ambient Temperature correction Factors, Installation Requirements, Wiring methods, Alternating Current Solar modules, siting requirements, operational limitations.		Explain different modes of operatin of solar PV Systme?		
5	Introduction, Components, towers, Guy Wire Supported towers, Self Supporting Towers, Wind Turbines Fan Blade Electrical Generators, Operation, Performance	CO-2	Write the different components of a wind generation system?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 5)
6	Wind Turbine Ratings, Energy Output Estimate, Siting Requirements, Wind Farms, Operational Limitations, Passive Generation Technology, Temperature Limits, Turbulence, Flicker.	CO-2	What are the operational limitations of wind turbine system?	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 6)
7	Introduction, Components, Fuel Processor, Fuel Cell, Anode, electrolyte, Cathode, Fuel Cell Stack Power Converter, Operation, Electrolysis, combined heat and Power, Operational Advantages, Ratings,	CO-2	Explain the operation of fuel cell?	▫ Lecture ▫ Discussion	Quiz (Week 1-7) Seminar (Week 7)
8	Installation and Siting Requirements, Clearances, Operating Temperature, Outdoor locations, Indoor locations, Detection and Alarm System, Ventilation, Sources of Ignition, Proximity to Utilities, Operation and Siting Limitations.	CO-2	Describe the installation and sitting requirements of fuel cell generating system?	▫ Lecture ▫ Discussion	Assignment (Week 7-8) Seminar (Week 8)
9	**Mid-Test1**				
10	Introduction, Components, Operation, Grid connected operation, stand alone operation, shutdown procedures, paralleling multiple micro turbines, Common output bus,	CO-3	Explain the different modes of operation of micro turbines? Describe the different components of a micro turbine?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 10)
11	Input impedance, Ratings, Installation and siting requirements, emissions, site ratings, ambient temperature, elevation, intake or exhaust restrictions, Zoning ordinances, Operational Limitations.	CO-3	Describe the limitations of micro turbine generation system?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 11)

	ramming language requirements for process control				
12	Introduction, Components, Engine Generator, Induction Generator, Synchronous Generator, Ratings, Voltage Ratings, Power Ratings, Current Ratings, Synchronous Generators, Power Factor and Reactive Power, Stand and Prime ratings, Operation, Siting Requirements	CO-4	Explain the different types of engine generators? Describe the siting requirements of a Engine generators?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 13)
13	Synchronizing to Power Supply system, Controlled factors, Frequency, Voltage Magnitude, Phase Angle, Manual Synchronization, Voltage and Frequency Meters, Synchro Scope, Synchronizing Lights.	C0-4	Explain different methods of synchronization?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 14)
14	Introduction, Operation, Load Shring, Base Loading, peak shaving, Importing Power, Exporting Power, Zero Power Transfer, NEC requirements for grid connected operation, Resources with Electric power Systems, Distribution System Configurations, Primary Loop Distribution System, Primary Selective Distribution System, Secondary Selective Distribution System, Network Distribution System, IEEE 1457 requirements, Voltage Regulation, power monitoring, Grounding, Synchronization, Connect to Network Distribution Systems, Back Feeds, Disconnecting Means, Coordinated Equipment Ratings, Abnormal Operating Conditions, Power Quality, islanding	CO-4	Explain the NEC requirements for grid connected operation? Write the IEEE 1547 requirements?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 15)
15	Introduction, Generation Characteristics, Solar Photo Voltaic Power, Wind Power, Site Ratings, Design approach, Load Characteristics, Energy Consumption and Demand, Power Factor, Daily and Seasonal Load Profiles, electric Utility Billing Practices, Peak Demand charges, Demand Ratchet, Net metering,	CO-5	Explain different generation characteristics?	▫ Lecture ▫ Discussion	Quiz (Week 10-16) Seminar (Week 16)

	Power buy back, Interruptible Utility rate, Sizing Solar Photo Voltaic Systems, Insulation				
16	Series and Parallel solar module connections, Sizing Wind Power Systems, Capacity Factor, Role of the manufacturer, Sizing Fuel Cells and Micro Turbines, Electric Power Production, Combined Head and Power applications, Sizing Engine – Generators, Fuel Type Operating voltage, :Low Voltage Generators, Medium Generators, Power and Current Rating at 0.8 power factor., Load Shed.	CO-5	Explain sizing of different distribution generation technologies? .	▫ Lecture ▫ Discussion	Assignment (Week 16-17) Seminar (Week 17)
17	**Mid-Test 2**				
18/19	**END EXAM**				