DISTRIBUTED GENERATION
(ELECTIVE-II)

Course Code: 15EE2216

L	P	C
3	0	3

Pre requisites: Electrical Machines and power systems.

Course Outcomes: At the end of the course, a student will be able to

CO1: Classify various methods of power generation, goals of distributed generation and differentiate between stand-alone photo voltaic powers.

CO2: Describe the operation, performance, operational limitations, Temperature limits, and other aspects of Wind Turbine and Fuel cells.

CO3: Describe sitting requirements, restrictions, and operational limitations of microturbines.

CO4: Describe inter connected generation systems.

CO5: Analyze the size of Solar Photo Voltaic Systems, Wind Power Systems, Fuel Cells and Micro Turbines, Engine – Generators.

UNIT-I (10-Lectures)

OVER VIEW OF DISTRIBUTED GENERATION: Introduction, Distributed Generation Technologies, Solar Photo Voltaic Power, Wind Power, Fuel Cells, Micro Turbines, Engine Generators, Passive Vs Active Generation, Goals of Distributed Generation, Reducing the Electric Utility Bill, Improving System Reliability, Improving pay back of emergency, Selling Power, Generating Environmentally Friendly power, Electrical Utility companies and Distributed Generation.

SOLAR PHOTO VOLTAIC SYSTEMS: Introduction, Components, Foundation and Supports, Fixed Arrays, Tracking Arrays, Solar Arrays, Utility Interactive Power Inverter, Operation , Tilting angle of the array, Stand Alone Photo Voltaic Power, Grid Connected Photo Voltaic Power, Photo Voltaic Module Ratings, Voltage Ratings, Current Rating, Power

Rating, Maximum Open Circuit Voltage, Ambient Temperature correction Factors, Installation Requirements, Wiring methods, Alternating Current Solar modules, siting requirements, operational limitations.

UNIT-II (10-Lectures)

WIND POWER SYSTEMS: Introduction, Components, towers, Guy Wire Supported towers, Self Supporting Towers, Wind Turbines Fan Blade Electrical Generators, Operation, Performance, Wind Turbine Ratings, Energy Output Estimate, Siting Requirements, Wind Farms, Operational Limitations, Passive Generation Technology, Temperature Limits, Turbulence, Flicker.

FUEL CELLS: Introduction, Components, Fuel Processor, Fuel Cell, Anode, electrolyte, Cathode, Fuel Cell Stack Power Converter, Operation, Electrolysis, combined heat and Power, Operational Advantages, Ratings, 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.

UNIT-III (10-Lectures)

MICRO-TURBINES: Introduction, Components, Operation, Grid connected operation, standalone operation, shutdown procedures, paralleling multiple micro turbines, Common output bus, input impedance, Ratings, Installation and siting requirements, emissions, site ratings, ambient temperature, elevation, intake or exhaust restrictions, Zoning ordinances, Operational Limitations.

UNIT-IV (10-Lectures)

ENGINE GENERATORS: 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, Synchronizing to Power Supply system,

Controlled factors, Frequency, Voltage Magnitude, Phase Angle, Manual Synchronization, Voltage and Frequency Meters, Synchro Scope, Synchronizing Lights.

INTERCONNECTED GENERATION SYSTEMS: Introduction, Operation, Load Sharing, Base Loading, peak shaving, Importing Power, Exporting Power, Zero Power Transfer, NEC requirements for grid connected operation, IEEE 1547, Standard for interconnecting Distributed Resources with Electric power Systems, Limitations of IEEE 1547,Distribution System Configurations, Primary Loop Distribution System, Primary Selective Distribution System, Secondary Selective Distribution System, Network Distribution System, IEEE 1547 requirements, Voltage Regulation, power monitoring, Grounding, Synchronization, Connection to Network Distribution Systems, Back Feeds, Disconnecting Means, Coordinated Equipment Ratings, Abnormal Operating Conditions, Power Quality, islanding.

UNIT-V (10-Lectures)

SIZING GENERATION SYSTEMS: 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, Power buy back, Interruptible Utility rate, Sizing Solar Photo Voltaic Systems, Insulation, 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.

TEXT BOOK:

1. Gregory W Massey, "*Essentials of Distributed Generation Systems*" – Jones and Bartlett Publishers, LLC, 2010.

REFERENCES:

1. Math H. J. Bollen and Fainan, "*Integration of Distributed Generation in Power Systems*" – Published by Hassan, John Wiley & Sons, Inc., Hoboken, New Jersey, IEEE Press, 2010.
2. Edited by Anne – Marie Borbely and Jan F. Krieder, "*Distributed Generation: The Power Paradigm for New Millennium*", CRC press LLC, 2001.