



# COE- Renewable and Sustainable Energy Studies

## Syllabus for PhD Entrance Examination

### Energy Engineering

Course Contents
Global and Indian Energy scenario, Renewable and non-renewable energy sources,
Small Scale Hydroelectric (Mini & Micro Hydel), Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Turbines and Generators for Small Scale Hydro Electric, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems.
Geothermal Energy Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.
Fuel Cells Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications,
Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies
Measurement & Instrumentation, classification, static and dynamic characteristics of instruments. Static characteristics of measuring instruments - accuracy, precision sensitivity, non-linearity, hysteresis - dynamic characteristics - I order and II order instruments - Standards and calibration - errors and error analysis.
Sensors and transducer, classification and selection of transducers, working principle of thermal, electrical, thermo-electrical, capacitive, inductive, photo-electric transducers
Flow measurement: orifice meter, venturimeter, pitot tubes, rotameter, turbo magnetic and electromagnetic flow meters, ultrasonic, gas flow metres, Velocity measurement: cup, vane and hotwire type anemometers Temperature measurement: Thermocouples, RTDs, Thermistors, Radiation and optical pyrometer, calibration
Solar Radiation: Solar Radiation, instruments for measuring solar radiation, solar radiation geometry, empirical equations, solar radiation on tilted surfaces. Solar time and equation of time, pyranometer & pyrliometer, solar spectrum, selective surfaces.
Liquid Flat Plate Collectors: Basic elements, performance analysis, transmissivity - absorptivity, heat transfer Coefficients and Correlations, Collector efficiency and heat removal factors, effects of various parameters, types of other liquid flat-plate Collectors, transient analysis
Solar Energy Storage: Basic methods, Sensible heat storage – liquids- solids-analysis, latent heat storage, thermo chemical storage, Solar pond, Battery Storage.

Solar Refrigeration: absorption based solar refrigeration technologies.
Photovoltaics: fundamental of photovoltaic conversion, semiconductor materials, photon energy, solar cell, material used in solar cell, polycrystalline & amorphous silicon, current voltage characteristics. Stand alone, Grid connected PV hybrid systems
Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Nuclear power plant
Classification of wind turbines, wind machine components, Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, wind Farms, wind mills & their applications, Cost economics, case studies.
Energy Audit Techniques, Fuel Analysis, Waste heat recovery, co-generation, Power Factor, Heat pipes, Energy conservation in Boilers, Compressors, Pumps, Furnaces, Buildings, Electric Motors, HVAC, Fans, Blowers, Lighting Systems
DC motor drives : dc motors & their performance (shunt, series, compound, permanent magnet motor, universal motor, dc servomotor) – braking – regenerative, dynamic braking, plugging – Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited & series motor with 1-phase and 3-phase converters – dual converter –analysis of chopper controlled dc drives .
Induction motor drives : stator voltage control of induction motor – torque-slip characteristics – operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non-sinusoidal voltage supply – stator frequency control – variable frequency operation – V/F control, controlled current and controlled slip operation – effect of harmonics and control of harmonics .
Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Voltage Regulation

#### Reference Books:

1. Twidell J & AW. Wier, Renewable energy resources, English Language book, Society I E& FN Spon (1986).
2. Sukhatme S.P., Solar Energy Principle of thermal collection and storage, TATA McGraw Hill Publishing company limited, New Delhi, 1996
3. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
4. D S Kumar, Mechanical measurements & Control, Third Edition, 2004, Metropolitan Book Co., Delhi
5. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
6. John A, Duffie, William A. Beckman ; Solar Engineering of thermal processes, , John Wiley and Sons, 1991.
7. Garg H.P. and Prakash J., Solar energy fundamentals and application, TATA McGraw Hill Publishing company limited, New Delhi, 2000.
8. L C Witte, P S Schmidt, D R Brown, Industrial Energy Management and Utilization, , Hemisphere Publishing Corporation ISBN 0-89116-322-0 (1988).
9. Energy Conservation Hand Books by Bureau of Energy Efficiency
10. I. J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)