SYLLABUS FOR POST OF PROJECT OFFICER (MTECH – RENEWABLE ENERGY)

PAPER – I

I) SOLAR TECHNOLOGY:

1.PV SYSTEM DESIGN AND INSTALLATION

An overview of Photovoltaic; types of Solar PV system, Solar PVTechnology & matching appliances; Electrical Circuit; Series and Parallel Circuits in power Sources; Series and Parallel Circuits in Electric Loads; Solar Radiation; Estimation of terrestrial Solar Radiation; Measurement of Solar Radiation; Gathering Site Data; Completing the Solar Site Analysis; Photovoltaic and Weather; Calculating Solar Energy & Solar Irradiance; Calculating Optimum Tilt for Solar Panels; Solar Panels and Shade; Effects of Temperature on Solar Panels; Surveying Your Site; Shading; Positioning Batteries, Controllers and Inverters; Electrical Load Analysis; Photovoltaic Module Performance; Review Design the Energy Storage System; Battery Sizing Exercise; Battery Wiring Configuration; PV Controllers; Controller Sizing Exercise; Inverters; Planning, Regulation and Approval; Grid Interconnection Requirement; Residential Design; Commercial Design; Photovoltaic Installation; PV Components Maintenance; Appliance Maintenance.

2. MATERIALS FOR SOLAR POWER

Introduction; Glazing material; Property and Characteristics of Materials; Reflection from surfaces; Selective Surfaces; Ideal coating characteristics; Types and applications; Anti- reflective coating; Preparation and Characterization of Thin film; Reflecting surfaces and transparent materials; Insulation and Properties; Physics of Solar Cells; Electrical Conductivity; Density of Electrons and Holes; Carriers transport; Drift; Diffusion; Absorption of light; Recombination Process; Materials for Photovoltaic Conversion; Technology for Si Extraction; Cell Fabrication and Metallization Techniques; Preparation of Metallurgical; Electronic and Solar Grade Silicon; Production of Single Crystal Silicon; Procedure of Masking; Photolithography and etching; Design of Complete silicon.

3. SOLAR THERMAL ENERGY CONVERSION

- Radiative properties and characteristics of materials
  Introduction; Reflection; Reflective surfaces; Transparent Surfaces; Selective surfaces; Ideal coating characteristics; Anti- reflective coating
- Solar radiation and Flat- plate collectors
  Solar Radiation; Measurement of solar radiation; Solar radiation terminologies; Estimation of solar radiation; Energy balance for flat plate collector; Thermal analysis of flat plate collector.
- Solar thermal energy storage
  Types of storage; Sensible storage; Latent heat storage; Thermo chemical storage; Design of storage system.
- Solar heating and cooling system

Heliostats; Solar power plant; Solar furnaces; Solar water heating systems; Cooling requirements of buildings.

- Solar applications
  Solar pond; Vapor absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar desiccant cooling.

4. **SOLAR CELL AND MODULE TECHNOLOGY**

The physics of solar cell; Properties of semiconductors; Equilibrium centre concentrators; Light absorptions; Recombination; Carrier transport; PN junction diode electrostatics; Solar cell fundamentals; Solar cell I-V characteristics; Efficiency and band gap; Spectral response; Parasitic resistance effect; Step in production Si wafers; Production of metallurgical silicon; Production of silicon for crystalline solar cells; Requirements of silicon for crystalline solar cells; Solar grade silicon; Bulk crystal growth and wafering for PV; Bulk multicrystalline silicon; Crystal Defects and Impurities; Wafering; Microscopic process of Wafering; Crystalline silicon solar cells; Manufacturing process- process flow; Manufacturing process- Screen- printing Technology; Manufacturing process- Throughput and Yield; Crystalline silicon photovoltaic modules; Thin film silicon solar cells; Thin film Deposition Techniques; Common Features of Thin Film Technology; Thin Film Module Manufacturing; Amorphous silicon solar cells technology; Amorphous silicon solar cell structure.

II) HYDRO POWER:

1. BUILDINGMATERIALS:

Bricks: Types, Indian standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.
Cement: Compound of different types, setting times, strength.
Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry.
Concrete: Importance of W/C Ratio, strength, ingredients including admixtures, workability, testing for strength, elasticity, nondestructive testing, mix design methods.

2. CONSTRUCTION PRACTICE, PLANNING ANDMANAGEMENT:

Concreting Equipment: Weight, batcher, mixer, vibrator, batching plant, concrete pump, granes, hoists, lifting equipment.
Earthwork Equipment: Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.
Construction, Planning and Management: Bar chart, link bar chart, work-break down structures, activity on-arrow diagrams. Critical path, probabilistic activity durations; Event-based networks. PERT network; time-cost study, crashing; Resources allocation

3. TYPES OF HYDROPOWER SCHEMES:

1. Run-of the-River 2) Storage/Pondage and different types and descriptions,

Advantages and disadvantages.

(b) HYDROPOWER COMPONENTS: Headworks/Weirs Types & Descriptions; De-silting/Filtration units; Water Conductor System - Channels/Syphons/conduits, Control of supply – Gates & Valves types and uses; Anchor/Saddles, Penstock-Types and description; Forebay/Surge Tanks - Types and descriptions; Spillway – Description; Powerhouse/Machine foundation types, Layout; Tailrace.

(c) ELECTRO-MECHANICAL:
Hydraulic Turbines - types, performance parameters, controls, selection; Control Systems and specifications; Switchyard and components – Specifications; Power Evacuation System.

4. HYDROLOGY:
Hydrological cycle, precipitation, forms of precipitation, measurement of rainfall, capacity ofreservoirs, streams flow and their gauging. Method of measurement-Direct method, area-velocity method, ultrasonic method, flow measurement structures.

5. SURVEYING*:*
Classification of surveys, scales, accuracy; measurement of distances-direct and indirect methods; optical and electronic devices; measurement of directions, prismatic compass, local attraction; theodolites-types; dumpy level, total station; measurement of elevations-spirit and trigonometric leveling; contours; digital elevation modeling concept; establishment of control by triangulations and traversing- measurements and adjustment of observations; concept of global positioning system; remote sensing concepts.

6. ESTIMATING:
(i) Introduction: General idea of estimating, use of standard estimating forms, use of schedule ofrates.
(ii) Units of measurement for different types of engineering works such as concrete, earthwork, masonry, roadwork, etc.
(iii) Types of Estimate: Plinth area estimate, cubic rate estimate, detailed estimate, revised estimate, supplementary estimate, annual repair estimate, contingency, departmental charge, bill of quantities & costing.

III) **WIND ENERGY**

Introduction; Power contained in Wind; Principle Wind Turbine Components; Wind Turbine Materials; Wind Turbine Topologies; Wind Turbine Power Curve; Economic Assessment of Wind Energy Systems; Value of Wind Energy; Problems; Wind Characteristics and Resources; General Characteristics of wind Resources; Characteristics of the Atmospheric Boundary; Wind Data Analysis and Resource Estimation; Wind Turbine Energy Production Estimates; Regional Wind Resource Assessment; Wind Prediction and Forecasting; Wind Measurement and Instrumentation; Problems; Wind Turbine Siting; Installation & Operational Issues; Offshore Wind Energy; Environmental Impacts of Wind Energy Systems;

Air foils and Concepts of Aerodynamics; Blade Design for Modern Wind Turbines; Momentum Theory & Blade Element Theory; Generalized Rotor Design Procedure Problems; Classification of Schemes with Variable- speed Turbines; Induction Generators; Stand- alone Configurations; Wind Turbine Control System; Wind Turbines and Wind Farms in Electrical Grids; Hybrid Power System.

PAPER - II

IV) BIOMASS ENERGY

Introduction; Biomass resources and their classification; Chemical constituents and physiochemical characteristics of biomass; Biomass conversion processes- Thermo chemical conversion; Direct combustion, gasification; Pyrolysis and liquefaction; biochemical conversion process, hydrolysis and Hydrogenation; Biogas generation- types of Biogas Plants; Thermal Biomass Conversion, Combustion, Pyrolysis, Biological Pathways; Gasification and Liquefaction; Biological Conversion, Methanol, Ethanol Production; Fermentation, Anaerobic Digestion; Biodegradability of Substrate; Hydrogen Generation from Algae; Biological Pathways; Power Production from different Organic Wastes; Effect of Additives on Biogas Yield; Biogas production from Dry Dung Cakes, Industrial Application; Viability of Energy Production; Wood Gasifier System; Operation of spark, Ignition and Compression Ignition with Wood Gas, Operation and Maintenance; Economics and Environmental Aspects; Energy Effectives and Cost Effectiveness, History of Energy Consumption and cost, Environmental Aspects of Bio energy Conversion, Economic analysis of bio energy options, Design, Selection, Construction and Operation of Biogas Plants; Design of the digester; Design based on end user requirements; Scaling of biogas plants; Digester sizing; Optimal design- design of fixed dome digester; Electricity Production from Biomass.

HYDROGEN AND FUEL CELLS

- Hydrogen- Basics and Production Techniques
  Introduction; Hydrogen- physical and chemical properties; Salient characteristics; Production of hydrogen; Steam reforming; Water electrolysis; Gasification and woody biomass conversion; Biological hydrogen production; Photo dissociation; Direct thermal or catalytic splitting of water.
- Hydrogen Storage and Applications
  Hydrogen storage options; Compressed gas; Liquid hydrogen; Hydride- Chemical Storage; Comparisons; Hydrogen transmission systems; Applications of Hydrogen.
- Fuel Cells
  History; Principle; Working; Thermodynamics and Kinetics of fuel cell process; Performance evaluation of fuel cell; Comparisons on battery Vs fuel cell.
- Fuel Cell- Types
  Types of fuel cells; AFC; PAFC; SOFC; MCFC; DMFC; PEMFC; Microbial fuel cell; Relative Merits and Demerits'
- Application of Fuel Cell and Economics

Fuel cell usage for domestic power systems; Large scale power generation; Automobile, Space; Economic and Environmental analysis on usage of Hydrogen and Fuel cell; Future trends in fuel cells.

ENERGY ENGINEERING

Definition and Units of Energy & Power; Forms of Energy; Conservation of Energy and its importance; Energy flow diagram to the Earth; Conventional and Non- conventional energy sources; Origin of fossil fuels; Fossil Fuel- Fired Power generation in India; Installed Capacity and Capacity Utilization; Production of coal and lignite in India; Foreign trade, Availability and Consumption in India; Energy commodity balance and Price in India; World Production and Consumption of Crude oil; World Production and Natural gas; Introduction and Overview of Solar Energy systems; Introduction and Overview of Wind Energy systems; Introduction and Overview of Bio-mass Energy systems; Introduction and Overview of Geothermal Energy systems; Introduction and Overview of Oceanic Energy systems; Hydrogen and Fuel Cell; MHD, Thermoelectric and Thermionic power conversion; Funding Agencies; Kyoto protocol; Primary and Secondary Pollution; Depletion of Ozone layer and Global Warming; Biological damage due to Environmental Degradation; Pollution due to thermal power generation and their control measures; Pollution due to nuclear power generation and their radioactive water & disposal; Effect of hydroelectric power stations on ecology and environment; Electric Grid operation, evolution of Smart Grids & their characteristics; Smart Grid Technologies Frame work; Smart Energy Resources; Smart Substations; Transmission systems; Distribution systems; Communication Systems Monitoring and Diagnostics; Geospatial Technologies; Asset Management; Smart Meters; Consumer Demand Management & Cyber Security.

ENERGY MANAGEMENT & AUDIT

Energy Scenario; Basics of Energy and its various forms; Energy Auditing definition, need, types and approach; Material and Energy balance; Energy Auction panning, Role and Responsibilities of Energy Auditor; Key Elements; Force Field Analysis; Energy Policy Purpose, perspective, contents, Formulation and Rectification; Location of Energy Management; Financial management; Project Management; Energy Monitoring and Targeting; Global Environmental Concerns; Fuels and Combustion; Boilers & its Energy Performance Assessment; Energy performance Assessment on turbine and Heat Exchanger; Steam Systems; Furnace and its energy performance assessment; Insulation and Refractions; Cogeneration & Energy performance Assessment; Waste Heat Recovery; Introduction to Electrical Power System; Electric motors; Energy performance assessment of Motors Performance Assessment; HVAC and Refrigeration system & its energy performance Assessment; Fans and Blowers and its Energy performance assessment; Pumps and Pumping system & energy performance Assessment.

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