

Syllabus for Entrance Exam for Renewable Energy Test Station (RETS)

1. Instrumentation

- 1.1 Theory of Measurement
- 1.2 Static Performance parameters; accuracy, precision, sensitivity, resolution, linearity
- 1.3 Dynamic Performance Parameters; Response time, frequency response, Band Width
- 1.4 Errors in measurement and calibration of measuring instruments
- 1.5 Transducers
- 1.6 Measurement of process variables; temperature, pressure, level, fluid flow, chemical constituent in gas, liquid, PH, Humidity
- 1.7 Electrical processing and transmission; OP-amp applications, instrumentation amplifier, attenuation, integration, differentiation, effect of noise on measurement

2. Electronic Device and Circuits

- 2.1 Zener Diode and its application
- 2.2 Bipolar Junction Diode; operation of npn transistor in active mode
- 2.3 Transistor as amplifiers
- 2.4 Graphical load analysis
- 2.5 Transistor as a Switch – Cutoff and saturation
- 2.6 Structure and Physical Operation of Enhancement-Type MOSFET
- 2.7 MOSFET as an Amplifier
- 2.8 Basic Principles of Sinusoidal Oscillator
- 2.9 Op Amp-RC Oscillator Circuits
- 2.10 Generation of Square and Triangular Waveforms Using Astable Multivibrators

3. Power Supplies, Breakdown Diodes, and Voltage Regulators

- 3.1 Unregulated Power Supply
- 3.2 Band gap Voltage Reference, a Constant Current Diodes
- 3.3 Transistor Series Regulators
- 3.4 Improving Regulator Performance
- 3.5 Current Limiting
- 3.6 Integrated Circuit Voltage Regulator

4. Electronics Device, Circuit and Techniques and Power supplies

- 4.1 Use, operation and characteristics of Diode, triode, pentode, Transistors, thyristor; measurement of resistance, capacitance, inductance, current, voltage in different R-C-L circuit, different types of amplifiers and rectifiers' usage and characteristics, Strain gauge and application, SCR (simple, phase control, temperature control, light control), close/open loop control and choppers, Boolean algebra, Logical gates and switching algebra, Memory (statics, volatile), A/D & D/A converter circuits, Sampling theory
- 4.2 Single phase and Poly phase AC power supply systems, Electrical motors, AC/DC generators, Rectifiers and filters, Regulator power supply system, Uninterruptible Power Supply Systems.

5. NETWORK ANALYSIS

- 5.1 Ohms law, Kirchoff's law, nodal and mesh analysis
- 5.2 Series and parallel circuit, delta-star and star-delta transformation
- 5.3 Concept of complex Impedance and Admittance RLC series and parallel circuit
- 5.4 Network Theorem: Thevenins theorem, Nortons theorem, Superposition theorem,
- 5.5 Reciprocity theorem and Maximum power transfer theorem.
- 5.6 Resonance in series and parallel RLC circuit
- 5.7 Active, Reactive and Apparent power
- 5.8 Transient response of RLC circuit excited by DC and AC sources

6. STATIC AND DYNAMIC ELECTRICAL MACHINES

- 6.1 Transformer: Working principle, Equivalent Circuit, Losses and efficiency, Voltage regulation, Transformer tests, Auto transformer, Three phase transformer connections, Parallel operation
- 6.2 D.C. Machine: Constructional detail, Operation in motoring and generating mode, Back emf in DC motor, Types of DC motor, their characteristics and applications, DC motor starter, Speed control of DC motor
- 6.3 Induction machine: Equivalent circuit, Torque-speed characteristic, Losses and efficiency, Starting methods, Speed control of three phase induction motor, Induction motor tests, Single phase induction motors- types, characteristics and applications
- 6.4 Synchronous machine: Salient pole and cylindrical rotor construction, generating and motoring principle, phasor diagram and power angle characteristics, Parallel operation of synchronous generators, Starting methods for synchronous motor, Effect of excitation, V and Inverted V curves, Synchronous condenser

7. Material Science and Metallurgy

- 7.1 Types of Materials, Material Selection
- 7.2 Imperfections in Atomic Arrangement: Slip and Twinning, Dislocation, Points and Surface Defects
- 7.3 Mechanical Properties and Testing: Tension, Impact, Fatigue, Hardness Test
- 7.4 Cold working and Hot working
- 7.5 Types of steel
- 7.6 Phase Transformation and Heat Treatment: Iron-carbon equilibrium diagram, Hardening, Tempering, Annealing, Normalizing

8. Hydraulic and Electric Machines

- 8.1 Water turbines: Pelton, Francis, Kaplan and Cross flow (Working principle and Characteristic)
- 8.2 Pumps: Centrifugal pump and reciprocating pump (Working principle and Characteristic), Hydraulic ram
- 8.3 DC Motors: Shunt field, Series field and Compound field motors, Torque speed characteristics
- 8.4 DC Generators: Shunt, Series and Compound field machines, Voltage/speed/load characteristics, Effects of variable load, variable torque

- 8.5 Synchronous and Induction Machines: Basic structure of synchronous Machines, Generator on isolated load, Generator on large system, Synchronous motor

9. Energy Resources

- 9.1 Energy consumption scenario of Nepal
- 9.2 Renewable energy and its applications: Solar thermal, solar photovoltaic, wind, micro hydro
- 9.3 Organizations involving in RE technology in Nepal
- 9.4 Renewable Energy Policy and its prospects
- 9.5 Basics terminologies in Solar Photovoltaic System ;solar constant, Irradiance, Peak sun , Air mass, Albedo effect, Direct and diffused solar radiation,
- 9.6 Applications of solar energy (thermal/PV), examples
- 9.7 Fundamental of Solar PV Technology: Photo-Voltaic effect, Solar Cells, PV Modules, Solar array
- 9.8 Global scenario of PV installations (grid tied and isolated grids, roof top programs), feed in tariffs, legislations, success and failure stories, RE policies of Nepal, policy gaps and measures
- 9.9 Physics of solar cells, basic parameters and definitions, IV curves, FF, effect of temperature on performance on power output of PV module
- 9.10 Components of Solar Photovoltaic system; PV module, types, Charge controller; method of charging, Battery and Lamp; CFL, TL, WLED, inverter
- 9.11 Design principles of solar PV based water pumping systems, hydraulic and electrical energy relations, array sizing and pump selection, line wiring diagrams, protection
- 9.12 System sizing of a water pumping project for a medium sized village in the hilly region
- 9.13 Grid connected PV plants (idea, basic parameters, synchronization issues, grid-interactive inverters, protections
- 9.14 Nepal Photovoltaic Quality Assurance System in Practice
- 9.15 Labs (measurements of voltage, current, power, irradiance, use of compass and slant rule
- 9.16 Design of Solar PV System
- 9.17 Grid connection to PV System
- 9.18 Biogas, bio-Ethanol, methanol, Improved cook stoves, Hydroelectricity

10. Solar thermal and flat plate collectors

- 10.1 Fundamental of solar Thermal system; Active and passive heating system
- 10.2 Scope of Solar heating system in Nepal; solar dryers, solar cooker and their technology,
- 10.3 General description, energy balance equation, temperature distribution, overall heat transfer coefficient, temperature distribution, flat plate collector performance
- 10.4 Solar Water heating: Water heating systems, freezing and boiling, auxiliary energy, forced circulation systems, natural circulation systems, water heating in space heating and cooling systems, combined collector storage, swimming pool heating
- 10.5 Types of domestic water heating systems, installation techniques, flaws and faults in installation, hot water requirement estimation

11. Industrial Engineering and Management

- 11.1 Role of production/Operation Management and System Concepts
- 11.2 Plant Location and Plant Layout Design

- 11.3 Production Planning and Control: Selection of materials, methods, machines and manpower, Network methods: PERT, CPM
- 11.4 Inventory Control: Inventory costs and Inventory models
- 11.5 Forecasting Techniques: Requirements of forecasting, Time series and Moving average methods, Regression analysis
- 11.6 Quality Management: Importance of quality, Statistical process control
- 11.7 Statistical Analysis: Measurement of central tendency, Deviation, Distribution

12. Engineering Economics

- 12.1 Types of engineering economics decisions
- 12.2 Time Value of Money: Simple interest, Compound interest, Continuous Compound interest
- 12.3 Project Evaluation Techniques: Payback period method, NPV method, Future Value analysis, IRR method
- 12.4 Benefit and Cost Analysis: Cost benefit ratio, breakeven analysis
- 12.5 Depreciation and its types

13. Environmental Engineering

- 13.1 Air Pollution: Causes and effects
- 13.2 Water Pollution: Causes and effects, Waste water treatment
- 13.3 Industrial Waste: Collection and disposal
- 13.4 Indoor Air Quality: Indoor pollutants, Effects of indoor pollutants and Control of indoor pollutants
- 13.5 Global impacts: Green house effects, Acid rain, Montreal Protocol, Clean Development Mechanism

14. Management

- 14.1 Planning, Organizing, Controlling, Decision Making in laboratory management
- 14.2 Organizational Behavior, leadership skill , motivational tools
- 14.3 Human Resource Management
- 14.4 Conflict Resolution Technique

15. Operational Research

- 15.1 Quantitative Techniques in Decision Making
- 15.2 Production and operational Management
- 15.3 Sampling techniques
- 15.4 Quality Assurance system in practice
- 15.5 Management information system