Nepal Engineering Council Registration Examination

Energy Engineering Syllabus (AEnE)

Chapters 1 is related to fundamentals/principles of concepts in energy; chapters 2-8 are related to engineering and applications of major energy resources and energy storage systems; chapter 9 is related to energy audit and management and the last (10th) chapter is related to sustainable development practices and financial analysis.

1. **Energy and its Uses** **(*AEnE* 01)**

1.1 Defining of energy, units and scales of energy use, energy production and consumption, local and global effects of energy. (***AEnE* 0101**)

1.2 Mechanical energy and transport, heat energy, conversion between heat and mechanical energy, electromagnetic energy and its storage, conversion, transmission and radiation, energy in chemical systems and processes. (***AEnE* 0102**)

1.3 Quantum mechanics and energy quantization, entropy and temperature, heat engines. (***AEnE* 0103**)

1.4 Types of energy resources: Commercial and traditional energy, conventional and non-conventional energy, renewable and non-renewable energy, sustainable and non-sustainable energy. (***AEnE* 0104**)

1.5 Classification of traditional fuels, refining of crude oil, properties of gasoline and diesel. (***AEnE* 0105**)

1.6 Conversion of energy, phase change energy conversion, refrigeration and heat pumps, internal combustion engines, steam and gas power cycles, the physics of power plants. (***AEnE* 0106**)

2. **Solar Energy** **(AEnE02)**

2.1 Solar radiation and its characteristics, solar radiation measuring devices. (AEnE0201)

2.2 Solar radiation fundamentals and solar angles. (AEnE0202)

2.3 Solar thermal systems: basic principles of heat transfer, selective coatings, principles and performance of flat plate and solar concentrators. (AEnE02003)

2.4 Application of thermal systems, solar water heating, solar pond, solar swimming pool, solar stills, solar drying, solar cooling and solar cooking, conversion to mechanical energy, application of active and passives solar thermal system in buildings. (AEnE0204)

2.5 Solar Photovoltaic systems: Photovoltaic materials; Materials in bulk and thin film forms, Role of microstructure (single crystal, multi-crystalline, polycrystalline, amorphous and nano-crystalline) in electrical and optical properties of the materials, types of solar cells and their fabrication. (AEnE0205)

2.6 Application of photovoltaic systems (modules and arrays), pumping systems, lighting systems, satellite solar power systems, solar home problems, PV cathodic protection, and other related problems, PV Tracking Systems, solar power generation. (AEnE0206)

3. **Bio Energy** **(AEnE03)**

3.1 Biomass energy resources, global and national potentials, energy conversion technologies, and its applications. Solid biomass (Fuel Wood, Agricultural Residues, Animal Residues), Liquid Bio-fuel Energy (Bioethanol, Bio-diesel, Bio-hydrocarbons,) and gaseous

biomass fuel (biogas).
(AEnE0301)
3.2 Biogas plants, biogas generation and factors affecting bio digestion or generation of gas, design concept and parameters of Biogas Plant. (AEnE0302)
3.3 Biomass and biochemical conversion to fuels, Synthetic fuels from the biomass. (AEnE0303)
3.4 Thermo-chemical, physio-chemical and bio-chemical conversion. (AEnE0304)
3.5 Bio-fuel cells, bio-electrochemical system, microbial fuel cell, enzymatic biofuel cell. (AEnE0305)
3.6 Different application of bio-energy, biomass power plant, biomass thermal plant.

(AEnE0306)

4. **Wind Energy** **(AEnE04)**
4.1 Fluid dynamics and power in the wind, available resources, viscosity, types of fluid flow, lift. (AEnE0401)
4.2 Historical evolution of wind energy, use of wind energy, general characteristics of wind energy resources, wind data analysis and resource estimation, overview of available resource assessment data. (AEnE0402)
4.3 Principles of wind energy conversion, wind measurement and instrumentation. (AEnE0403)
4.4 Types of machine characteristics of wind turbines, wind machine performance, types of machines, horizontal & vertical axis wind turbines, Savonious rotor, Darrieous rotor, and multi-blade form wind mills, high speed rotors, enhanced performance machines etc. (AEnE0404)
4.5 Wind Energy System Design: Wind turbine design, generators and electrical component design of wind turbines, wind turbine control system, wind turbine siting, system design and integration. (AEnE0405)
4.6 Wind energy applications systems – wind power for large and small scale utilization, water pumping, grinding and electricity generation, wind farming, economics of wind energy system.
(AEnE0406)

5. **Micro and Small Hydro Power Systems** (AEnE05)
5.1 Micro/Mini hydropower (MHP) systems, principles and related technologies. (AEnE0501)
5.2 Site investigation, hydrology and site survey, layout design and selection of components, installing, commissioning and testing, repair and maintenance, MHP Project Evaluation. (AEnE0502)
5.3 Construction and operation of the different types of water turbines within the range of micro and small hydro power systems. (AEnE0503)
5.4 Characteristics of turbines used for micro and small hydro power plants. (AEnE0504)
5.5 National and international plan and policies on MHP. (AEnE0505)
5.6 Grid connection of MHP. (AEnE0506)

6. **Non-conventional and other forms of Energy** (AEnE06)

6.1 Properties of hydrogen and brief history of hydrogen fuel. Hydrogen production processes and infrastructure requirement. (AEnE0601)

6.2 Hydrogen storage for stationary and mobile applications, Utilization of hydrogen and hydrogen economy. (AEnE0602)

6.3 Introduction to fuel cells and hydrogen fuel system, basics of electrochemistry, Polymer Membrane Electrolyte (PEM) fuel cells, Solid Oxide Fuel Cells (SOFCs), Coal-fired plants and Integrated Gasifier Fuel Cell (IGFC) systems. (AEnE0603)

6.4 Geological structure of earth, geophysics, geothermal resources. Application of geothermal energy: direct use of hot water and steam, heating and cooling system using hot aquifer thermal energy storage system etc. Extraction of geothermal energy: equipments and materials and pumps selections. Geothermal steam supply from wellhead to turbine. Geothermal power production: Steam turbine and binary power plant technologies, other applications. (AEnE0604)

6.5 Wave Energy: Wave motion and wave energy resource, types, potential, wave energy and power, wave energy harnessing devices. (AEnE0605)

6.6 Tidal Energy: Origin, nature and enhancement of tides, principle of tidal current/stream power, tidal range power and conversion technologies, tidal energy schemes and modes of operation of tidal power schemes. (AEnE0606)

7. **Nuclear Energy** **(AEnE07)**

7.1 Introduction of nuclear forces, energy scales and structure, nuclear binding energy , reactions and decays. (AEnE0701)

7.2 Nuclear fusion and reactions. Requirements for nuclear fusion. (AEnE0702)

7.3 Nuclear fission and fission reactor physics. Nuclear fission reactor design. (AEnE0703)

7.4 Health hazards, safety, radiation protection & shielding. (AEnE0704)

7.5 Nuclear radiation, fuel cycles, waste and proliferation. (AEnE0705)

7.6 Application of nuclear energy for power and other uses. (AEnE0706)

8. **Energy Storage** (AEnE08)

8.1 Need and forms of energy storage systems, electro-chemical storage, mechanical systems, thermal systems, hydrogen systems. (AEnE0801)

8.2 Batteries: Energy density and storage capabilities of batteries, charge/discharge curves for the most common types of rechargeable batteries and interpret concepts describing battery performance (SOC, SOH, etc.). (AEnE0802)

8.3 Electrochemical Double-layer Capacitors, Regenerative Fuel Cells, Compressed Air, Flywheel, Superconductive Magnetic Energy Storage, Thermo-Electric Energy Storage. (AEnE0803)

8.4 Hybrid energy storage devices and their applications. (AEnE0804)

8.5 Applications of energy storage devices: regenerative brake, smart grid systems, hybrid electric vehicle. (AEnE0805)

8.6 Energy storage in power plant: Pumped Storage Hydroelectricity, Compressed Air Energy Storage, Electrolysis of water and Methanation etc. (AEnE0806)

9. **Energy Audit** **(AEnE09)**

9.1 Energy audit concepts: Definition, objectives/need of energy audit, history of energy audit, benefits of energy audit. Audit methodology or phases of energy audit (investigation, monitoring, analysis & reporting). Systematic Approach to Energy Auditing. (AEnE0901)

9.2 Types of energy audit (Basic/walk through audit, detailed/energy diagnosis, precision subsystem/investment grade audit). Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy, get facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, material(mass) and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation, Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization. Evaluation of saving opportunities: Determining the savings in monitory term, Noneconomic factors, Conservation opportunities, estimating cost of implementation. Energy Audit Reporting and its importance, contents, effective organization, report writing and presentation. (AEnE0902)

9.3 Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. Light meter, Thermometers, Tape Measures, Voltmeter, Wattmeter/Power Factor Meter, Power Quality Analyzer, Gas Leak Detector, Combustion Analyzer, Airflow Measurement Devices, Blower Door Attachment, thermal image camera. (AEnE0903)

9.4 Energy Audit of Thermal Components: Parameters for Thermal Energy Audit, Temperature, Pressure, Humidity, Combustion measurements, flow measurements, thermal insulation. Energy audit for Furnaces, Boilers, Steam distribution system, Heat Recovery Systems, Cogeneration, Cooling towers, Heating Ventilation and Air Conditioning (HVAC), and Refrigeration. (AEnE0904)

9.5 Energy Audit of Electrical and Electro-Mechanical Components: Understanding utility bill, tariffs, and demand charges. Parameters for Electrical and Electro-mechanical Audit: Voltage, Current, Power, Energy, Power Factor, Frequency, Harmonics, Load pattern, motor speed, Insulation resistance, Earth resistance, Speed, leakage rate. Power factor improvement including cause and disadvantages of low power factor, methods to improve power factor, Demand Side Management. Energy audit for Energy efficient lighting system, Fans and blowers, Compressor, Pumps, Electrical Motor, Battery bank, Capacitor bank, Transformer Loading, Captive Power Generator. (AEnE0906)

9.6 Building Energy Audit: Principles of Building Envelope Analysis, Heat transfer from components of Building Envelops. Summarizing Envelope Performance with the Building Load Coefficient. Simplified Calculation Tools for Building Envelope Audit. Selected Retrofits for Building Envelope.
(AEnE0906)

10. Project Planning, Design and Implementation **(AALL10)**

10.1 Engineering drawings and its concepts: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, orthographic projection, isometric projection/view, pictorial views, and sectional drawing. (AALL1001)

10.2 Engineering Economics: understanding of project cash flow; discount rate, interest and time value of money; basic methodologies for engineering economics analysis (Discounted Payback Period, NPV,

IRR & MARR); comparison of alternatives, depreciation system and taxation system in Nepal. (AALL1002)

10.3 Project planning and scheduling: project classifications; project life cycle phases; project planning process; project scheduling (bar chart, CPM, PERT); resources levelling and smoothing; monitoring/evaluation/controlling. (AALL1003)

10.4 Project management: Information system; project risk analysis and management; project financing, tender and its process, and contract management. (AALL1004)

10.5 Engineering professional practice: Environment and society; professional ethics; regulatory environment; contemporary issues/problems in engineering; occupational health and safety; roles/responsibilities of Nepal Engineers Association (NEA). (AALL1005)

10.6 Engineering Regulatory Body: Nepal Engineering Council (Acts & Regulations). (AALL1006)