Nepal Engineering Council Registration Examination

Electrical Engineering (AElE)

Chapters 1-2 are fundamentals/basic principles of concepts in Electrical Engineering; chapter 3 is related to fundamental application of hydro-electric power plant; chapter 4-6 are related to the measurement, protection and control of electrical equipment; chapters 7-9 are related to transmission and distribution lines, utilization of energy, and analysis of electric power system; and the last (10^{th}) chapter is related to project planning, design and implementation.

1. Fundamental of Electrical Engineering (AElE01)

1.1 Basic circuit concept: Ohm´s law, voltage, current, power and energy, conducting and insulating materials. Series and parallel electric circuits, star-delta and delta-star conversion, Kirchhoff's law, linear and non-linear circuit, bilateral and unilateral circuits, active and passive circuits. (AExE0101)

1.2 Network theorems: Superposition theorem, Thevenin`s theorem, Norton`s theorem, Maximum power transfer theorem. (AExE0102)

1.3 Alternating current fundamentals: Principle of generation of alternating voltages and currents and their equations and waveforms, average, peak and rms values. (AElE0103)

1.4 Electric circuit responses: Steady State and Transient analysis of R-L, R-C, R-L-C circuits (AElE0104)

1.5 AC series and parallel circuits: Active, reactive and apparent power, Power Factor Resonance (AElE0105)

1.6 Three phase systems: star and delta connection of three phase system, relation between line and phase voltage, neutral concept, effect of unbalance load in three phase system, active and reactive power (AElE0106)

2. Electrical Machines (AElE02)

2.1 Magnetic circuits: Flux linkage, inductance and energy; magnetic materials and their properties; magnetically induced emf and force (AElE0201)

2.2 Transformers: Core and shell type transformers, parts of transformers; tank, conservators, breather, explosion vent, bushings, transformer oil etc. no-load and on-load operation of transformers, Equivalent circuits, transformer tests, hysteresis and eddy current losses and efficiency, condition for maximum efficiency, three phase transformer connections; parallel operation of transformers; transformer capacity; temperature rise (AElE0202)

2.3 DC machines: Construction detail; Working principles; operating characteristics of different types of DC generators and motors, armature reaction; losses and efficiency; applications, starting and speed control of DC motors. (AElE0203)

2.4 Synchronous machines: Construction and working principle, armature and field winding, different types of excitation systems, equation of induced E.M.F., speed and frequency correlation, voltage and frequency regulation, losses and efficiency, parallel operation and synchronizing, alternators connected to infinite bus bars, Synchronous motors: Working principle, application, starting methods (AElE0204)

2.5 Three phase induction motors: construction detail, squirrel cage and phase wound type, working principles, equivalent circuits, torque slip characteristics, effect of rotor resistance, starting methods, no-load and block rotor tests, methods of speed control. (AElE0205)

2.6 Single phase induction motor: Construction, Operation and Characteristics of single-phase motors: Split phase motors, shaded pole motors, applications, Speed control (AElE0206)

3. Power Plants Engineering (AElE03)

3.1 Hydroelectric power plants: Classifications and respective layouts, selection of sites, types of water turbines, their working principles and applications, governing of water turbines, Hydro-plant auxiliaries. (AElE0301)

3.2 Diesel electric power plants: Selection of sites, elements of a diesel plant and its layout. (AElE0302)

3.3 Non-conventional power generation: Solar Power Generation, Wind Power Generation (AElE0303)

3.4 Energy storages: Pumped Storage Plants, Battery Energy Storage, Compressed Air Storage and Flywheel Storage (AElE0304)

3.5 Excitation systems: DC excitation system, AC excitation system, static excitation system, brushless excitation system, Automatic voltage regulator: Construction and Operation (AElE0305)

3.6 Starting of generators: Prerequisites for starting of generators in hydro and diesel station, B lack start units in power stations (AElE0306)

4. Electrical Measurements and Instrumentations (AElE04)

4.1 Measurement and error: Static and Dynamic Errors, Maxwell bridges, Schering Bridge, Wien bridge (AElE0401)

4.2 Measuring instruments: Moving Coil and Moving Iron Instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter and Power Factor Meter, Measurement of resistances (AElE0402)

4.3 Transducers and sensors: Electrical, Mechanical and Thermal: Potentiometer, LVDT, Strain Gauge, load cell, Hall Effect Sensors, Piezoelectric Sensors, Capacitive Sensors, thermistor, thermocouples, photoconductive cells, photo diodes (AElE0403)

4.4 Analog to digital and digital to analog converters: Weighted resistor type and Ladder type D/A converters, Dual-ramp type and Successive approximation type A/D converters (AElE0404)

4.5 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation (AElE0405)

4.6 Instrument transformers: Construction and Operating Principles of Measuring and Protection type CTs, Potential Transformers (AElE0406)

5. Power Electronics and Control (AElE05)

5.1 Control system fundamentals: Open Loop and Closed Loop system, System Transfer Function (AElE0501)

5.2 Time domain analysis: First Order System, Second Order System, Control System Stability, pole zero plot, Root Locus, PID Controller (AElE0502)

5.3 Frequency domain analysis: Bode Plot, Nyquist Plot (AElE0503)

5.4 Power semiconductor switches: Construction and Characteristics of power diode, Thyristors, GTO, TRAIC, IGBT and MOSFET, Power loss in Power Switches, Protection of Power Switching Devices and Circuits. (AElE0504)

5.5 Power converters: Rectifiers: Operating principle, half wave and full wave rectifier, Performance parameters of rectifier and THD evaluation, power factor improvement techniques, Inverters: basic principle of inverter, output waveforms, THD evaluation, Pulse Width Modulation for Inverters. DC-DC converters: principle of operation of DC-DC converters, output waveforms, average output voltage (AElE0505)

5.6 Applications of power electronics: Operation of UPS and types and components of HVDC Transmission System (AElE0506)

6. Power System Protection **(AElE06)**

6.1 Fuses, isolators and reactors: Fuse types, construction, characteristics and application; Isolators types, construction, operation and application; reactors and their selections (AElE0601)

6.2 Circuit breakers: Construction operation and application of air, vacuum, oil and gas filled circuit breakers, specification, rating, testing and selection of circuit breakers, MCB and MCCB protection. (AElE0602)

6.3 Protective relays: Over current, earth fault and under voltage relays, isolators and contactors. Overload and short circuit protection, earth fault protection, differential protection, distance protection. (AElE0603)

6.4 Lightning protection: Lightning phenomenon, types and functions of lightning arrestor, overhead earth wire (AElE0604)

6.5 Earthing: System and Equipment Earthing, Safety and precautions (AElE0605)

6.6 Substations: Types of substations, bus bar arrangements, earthing of equipment's in a substation, role of auxiliary equipment and measuring accessories, Compensation devices: Tap changing in transformer, booster transformer, synchronous condensers and static compensators. (AElE0606)

7. Transmission and Distribution Lines **(AElE07)**

7.1 Transmission lines: Overhead transmission line and underground cabling (AElE0701)

7.2 Transmission lines circuit selection: Necessity of high voltage transmission, choice of voltage level, conductor spacing, insulating materials and their classification, voltage regulation and efficiency of short and medium transmission lines, (AElE0702)

7.3 Mechanical design of overhead line: Sag, tension and clearances, supports and cross arms, conducting materials, types of Insulators, String Efficiency, Jumpers and vibrations dampers in transmission lines (AElE0703)

7.4 Electrical loads: Types, characteristic and load forecast (AElE0704)

7.5 Distribution systems: Primary distribution system: Radial system, ring main system and interconnected network system. Secondary distribution system: Three phase four wire distribution, single phase two wire distribution, Selection of supports and conductors in secondary distribution system, stay wire (AElE0705)

7.6 Voltage regulation and power factor correction: Voltage regulation in distribution system, power factor correction (AElE0706)

8. Utilization of Electrical Energy **(AElE08)**

8.1 Illumination: luminous flux, luminous intensity, construction and working principle of incandescent lamps, fluorescent lamps, CFL, LED, indoor and outdoor lighting schemes (AElE0801)

8.2 Electrical design and estimation: Electrical Drawing, Estimation and Costing for buildings and industrial complexes; National Building Code; National electricity standards and codes. (AElE0802)

8.3 Tariff schemes: Types of tariffs, tariff schemes in Nepal; Nepal Electricity Regulations and Acts. (AElE0803)

8.4 Electric drives and motor selection: types of electric drives, motor sizing and power torque calculation (AElE0804)

8.5 Electric heating: Types and Application, Electrical energy conservation measures (AElE0805)

8.6 Electric traction: Types of electric traction, Types of motors used for electric traction, starting and speed control of electric motors for tramway, trolley bus, electric train, elevators (AElE0806)

9. Power System Analysis **(AElE09)**

9.1 Transmission line parameters: Computation of series and shunt parameters of transmission line

equivalent circuits, concept of GMD and GMR, proximity effect and skin effect; **Corona**: corona inception voltage, power loss, Per unit system representation: Single line impedance and reactance diagrams. (AElE0901)

9.2 Performance of transmission line: Lumped and distributed parameter modeling, ABCD parameters, efficiency & regulations calculations, Feranti effect, surge impedance loading (AElE0902)

9.3 Fault calculations: Symmetrical components, grounded & ungrounded systems, L-G, L-L, L-L-G and 3-phase faults. (AElE0903)

9.4 Load flow: Y-bus of a power system network, Gauss-Seidal and Newton-Rapshon methods (AElE0904)

9.5 Stability analysis: Steady state & transient stability limits, swing equations, equal area criterion, stability enhancement techniques, Voltage Stability (AElE0905)

9.6 Voltage control and VAR compensation: Real and reactive power flow through transmission line, series and shunt compensations (AElE0906)

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)