Nepal Engineering Council Registration Examination

Electrical and Electronic Engineering (AEEE)

Chapters 1-4 are fundamentals/principles of concepts in Electrical and Electronic engineering; chapters 5-9 are related to application of engineering principles in practice; and the last (10^{th}) chapter is related to project planning, design and implementation.

1. Fundamentals of Electrical Components and Circuits (AEEE01)

1.1 Basic concept: Ohm´s law, electric voltage current, power and energy, conducting and insulating materials. Series and parallel electric circuits, start-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: concept of superposition theorem, Thevenin`s theorem, Norton`s theorem, maximum power transfer theorem. R-L, R-C, R-L-C circuits, resonance in AC series and parallel circuit, active and reactive power. (AExE0102)

1.3 Alternating current fundamentals: Principle of generation of alternating voltages and currents and their equations and waveforms, average, peak and rms values, three phase system. (AExE0103)

1.4 Electric recruit response (transient analysis): Steady State and Transient analysis of R-L, R-C, R-L-C circuits. (AElE0104)

1.5 Analysis of one port and two port networks: Transfer functions, Poles and Zeros of Networks, Relationship between poles/zeros locations and system response, One Port Passive Circuits, Impedance and admittance functions, Two-Port Parameters of Networks, Definitions of two-port networks, Short circuit admittance parameters, Open circuit impedance parameters, Transmission parameters, Hybrid parameters, inter-relationship between parameters of two port network, series, parallel and cascade networks. (AEEE0105)

1.6 Synthesis of one port and two port networks: Hurwitz polynomials and properties, Positive real functions, Foster and Cauer forms, Synthesis of RL, RC and LC networks, synthesis of resistively terminated active and passive two ports, Ladder networks. (AEEE0106)

2. Fundamentals of Electronic Devices and Circuits (AEEE02)

2.1 Semiconductor diodes and transistors: Overview of electronic devices and circuits: Semiconductor diode, PN junction characteristics; Ideal and Practical Diode; I-V characteristics; Forward and reverse bias; Diode configuration (Series, Parallel and Hybrid), Large signal and small signal model, half wave and full wave rectifiers, Various types of diodes, Bipolar Junction Transistor (BJT), PNP and NPN transistor, mode of operation, Concept of amplifier, Common Base (CB), Common Emitter (CE), Common Collector (CC), transistor characteristics; input characteristic, output characteristic, current gain characteristic. BJT biasing. (AEEE0201)

2.2 JFET and MOSFET: Field Effect Transistor (FET), Junction field effect transistor (JFET)- Construction, Basic operation and Characteristics, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) structure and operation, Types of MOSFET, Current voltage characteristic, MOSFET as an amplifier and switch; biasing in MOSFET amplifier. Working principle of CMOS, Application of MOSFET and CMOS. (AEEE0202)

2.3 Amplifiers and signal generators: Basic definition of amplification and gain; Amplifier and its application, Brief overview of amplifier types- Voltage amplifiers, Current amplifiers, Design procedure of low frequency amplifier using BJT and MOSFET- Biasing, Small signal parameter, Gain and impedance calculation, Amplifier with negative feedback. Power amplifiers, Class A, Class B, Class AB

Amplifier. Basic Principles of Oscillator, Positive feedback, Condition for oscillation, RC, LC and Crystal Oscillators Circuits, Waveform generators- square wave generator, Triangular wave generator, Saw tooth wave generator. (AEEE0203)

2.4 Operational amplifier characterization: Overview of differential amplifier, Basic parameters of ideal Operational Amplifier (Op. Amp); Ideal and practical Characteristic of Op- Amp, Derivation of gain for basic inverting and non-inverting amplifiers with feedback; Concept of voltage follower and negative ground, Op-Amp Application- Integration, Differentiation, Addition, Clipping and comparator circuits. (AEEE0204)

2.5 Nonlinear circuits and active Filters: Logarithmic and exponential amplifier; Logarithmic multiplier; Phase locked loop; Voltage to frequency and frequency to voltage conversion, Characteristic of active filter; Advantage of active filter, Active first order filter, High pass and low pass. (AEEE0205)

2.6 Logic families and ICs: Evolution of logic families; Characteristics of logic families; Classification of logic families; Simple circuits for logic gates, DTL, RTL, TTL. (AEEE0206)

3. Digital Logic and Microprocessor (AEEE03)

3.1 Digital logic: Number Systems, Logic Levels, Logic Gates, Boolean algebra, Sum-of-Products Method, Product-of-Sums Method, Truth Table to Karnaugh Map. (AExE0201)

3.2 Combinational and arithmetic circuits: Multiplexetures, Demultiplexetures, Decoder, Encoder, Binary Addition, Binary Subtraction, operation on Unsigned and Signed Binary Numbers. (AExE0202)

3.3 Sequential logic circuit: RS Flip-Flops, Gated Flip-Flops, Edge Triggered Flip-Flops, Mater- Slave Flip-Flops. Types of Registers, Applications of Shift Registers, Asynchronous Counters, Synchronous Counters. (AExE0203)

3.4 Microprocessor: Internal Architecture and Features of microprocessor, Assembly Language Programming. (AExE0204)

3.5 Interfacing (Microprocessor system): Memory Device Classification and Hierarchy, Interfacing I/O and Memory Parallel Interface. Introduction to Programmable Peripheral Interface (PPI), Serial Interface, Synchronous and Asynchronous Transmission, Serial Interface Standards: RS232, RS423, RS422, USB, Introduction to USART, Introduction to Direct Memory Access (DMA) and DMA Controllers. (AExE0205)

3.6 Computer organization: Control and Central Processing unit, Control Memory, addressing sequencing, Computer configuration, Microinstruction Format, Design of control unit, CPU Structure and Function, Arithmetic and logic Unit, Instruction formats, addressing modes, Data transfer and manipulation, RISC and CISC Pipelining parallel processing (AEEE0306)

4. Computer Programming (AEEE04)

4.1 Introduction to programming: Tokens, Operators, Formatted/Unformatted Input/output, Structured and Object oriented programming, algorithms and flowcharts, Data Type, Variables, Declaration, Constants (Sting, Numeric, Character Constant), Arithmetic Operators, Assignment Operators, Logical and Comparison Operations, , Input Statement, Output Statement. (AEEE0401)

4.2 Control statements: If Statement, if-else Statement, switch statement, Loop Statements: for loop, while loop, do-while loop, Breaking Control Statements. (AEEE0402)

4.3 Functions: Defining Function, use of function, Function Prototypes, Passing Argument to a Function, Recursive function (AEEE0403)

4.4 Pointers and data file: Pointer Declaration, Pointer Arithmetic, Operation on Pointers, Pointer and Array (Pointer and one dimension Array), Dynamic Memory Allocation (AEEE0404)

4.5 Array and structures: Defining an Array, Processing an Array, Passing Array to Function, Multidimensional Array, Declaration of Structure, Initialization of Structure, Array of Structure, Pointer to Structure (AEEE0405)

4.6 Features of object-oriented programming: Inline Functions, Function, Overloading, Class and objects, member function, Private Member Functions, Initializing an Object, Static Data Members, Static Member Functions, Operator Overloading, inheritance, polymorphism. (AEEE0406)

5. Measurement, Instrumentation and Control (AEEE05)

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

5.2 Transducers, sensors and signal conditioning: Definitions, classifications of transducers, transducer selection factors, resistive transducers, capacitive transducers and inductive transducers, linear variable differential transformer, position and proximity sensors, motion sensors, pressure sensors, level sensors, flow sensors, strain gauges, load cells, resistance temperature detectors, thermistors, thermocouples, thermopiles, piezoelectric transducers, photoconductive cell, photo diode, photovoltaic cell, photo transistors, linearization techniques, signal conversion, filtering, impedance and power matching; Digital Signal Conditioning Circuits, DAC and its performance parameters, Binary weighted DAC, R/2R ladder DAC, Source of Errors in DAC, ADC and its performance parameters, Single ramp type and Dual slope type ADCs, successive approximation type ADC, flash type ADC (AEEE0502)

5.3 Electrical measurements and instruments: Essential requirements of an Instruments: deflection system, controlling system and Damping systems, PMMC instruments, Voltmeter types and working principle, Ammeter types and working principle, Ohmmeter types and working principle, Clamp-meter types and working principle, Multi-meter types and working principle, Wattmeter types and working principle, energy meter types and working principle, Time of day meter, power factor meter, frequency meter, Phase meter, Instrument Transformers types and working principle, Megger, tachometer. (AEEE0503)

5.4 System modeling: Control systems definition and classification, Open loop and closed loop systems, classification, Modeling Mechanical systems, Modeling of Electrical circuits, Transfer function, Modeling of liquid level systems, Modeling of thermal systems, Force-Voltage and Force-Current Analogous system, Modeling of gear and transformers, Modeling of sensors and encoders, generators, Modeling of electromechanical system, Modeling of mixed systems. (AEEE0504)

5.5 Block diagram representation: Rules for block diagram reduction, block diagram reduction examples, Definitions of Signal Flow Graph, Rules for construction of Signal Flow Graph, Block diagram to Signal Flow Graph, Signal Flow Graph to block diagram reduction conversion, mixed system its block diagram and Signal Flow Graph, Response of first order systems to test signals, Response of second order systems to test signals. (AEEE0505)

5.6 Stability analysis: Definitions of stability and stable systems, Routh Hurwitz criterion, Root locus plot-Introduction, Rules for constructing root locus, Frequency Response Analysis, Bode plot for different factors of transfer function, Stability criterion for Bode plot, Polar plots, Nyquist's stability criterion, and Stability margins. (AEEE0506)

6. Electrical Machines (AEEE06)

6.1 Transformers fundamentals: Importance and applications of transformers; Types and construction, Theory and operation of single-phase transformers, EMF equation, Vector diagram, No load and transient characteristics, Voltage regulation, Losses and efficiency, Equivalent circuits parameter, Transformer tests, Three phase transformers, Delta star connections, Introduction to pulse transformers and autotransformers. (AEEE0601)

6.2 DC generators: Generator principles, Construction, Winding, generator types, Losses and efficiency, No load and load characteristics, Armature reaction and commutation, Parallel operation of generators, Induced voltage and torque equations, Equivalent circuit magnetization curve. (AEEE0602)

6.3 DC motors: Motor principles, Types, Construction and output characteristics of different motors, Speed control, starting, applications, Losses and efficiency; Introduction to brushless DC motors; Testing of DC machines; Reversing and braking. (AEEE0603)

6.4 Induction motors: Principle of operation, Squirrel cage and wound rotor construction, Equivalent circuit, Synchronous speed, Slip and its effect on rotor frequency and voltage, Losses and efficiency, Torque-speed characteristics, Starting and speed control, Induction generator and its application, Single phase induction motor: torque-speed characteristics and applications of split-phase, capacitor start, Permanent split-capacitor, Two-value capacitor and shaded pole motors. (AEEE0604)

6.5 Synchronous generators: Introduction, Construction, winding diagram, Power and torque, Speed and frequency, EMF equation, Voltage regulation, Equivalent circuit, Generator Synchronization, Permanent Magnet Synchronous Generator and its application. (AEEE0605)

6.6 Synchronous motors: Principle of operation, Torque-angle characteristics, Method of starting, Counter voltage (CEMF) and armature reaction voltage, Excitation method, Power factor improvement, Speed control. (AEEE0606)

7. Signals, Systems and Frequency Domain Analysis (AEEE07)

7.1 Fundamentals of signal and systems: Signal classification: Continuous time and Discrete time signals, Periodic and aperiodic Signals. Energy and Power signals, Even and odd signals, Orthogonal signals, Casual, anticasual and noncasual signals, Transformation of signals: Time shifting, Time scaling, Time reversal, Combined operation, Unit impulse, Unit Step and Unit Ramp, Real exponential, Complex exponential and signum, System and Properties, Properties of LTI-systems, convolution integral, convolution sum. (AEEE0701)

7.2 Laplace transforms: Definition, Properties, Laplace transform of common forcing functions, inverse Laplace transforms, partial fraction expansion, Heaviside's expansion theorem, Application of Laplace transform in solving differential equations, Transfer function, frequency response. (AEEE0702)

7.3 Fourier series and transforms: CT Fourier series, Fourier integral: Representation of aperiodic and periodic signals; Forward and reverse/inverse Fourier transforms; Fourier transforms properties, Parseval's theorems, Discrete time Fourier series: Representation of periodic signals and properties; discrete time Fourier transform (DTFT): Representation of aperiodic signals; Forward and inverse/reverse DTFT; Properties of DTFT. (AEEE0703)

7.4 Z transform and digital systems: Sampling, The sampling theorem, Aliasing, Conversion to discrete time signals, Reconstruction and zero-order hold compensation, Definition of the z-transform, z-transform Properties: linearity, Shifting, convolution, Scaling, Relation between the Z-transform and the Fourier transform, Inverse z-transform: Partial fraction expansions, the inverse integral; System response, Transfer function H(z), Response to sinusoidal input - polezero relationships, Stability test of the discrete time system, DFT, FFT. (AEEE0704)

7.5 Application of frequency domain analysis: Stability analysis, spectral analysis, spectrum sensing, correlation, system design. (AEEE0705)

7.6 Filters: Filters and applications, ideal and digital filters, active and passive filters, frequency responses, Butterworth and Chebyshev filters, Introduction of digital filter, Basic types of filtering, Transfer function, Frequency response, FIR and IIR filters. (AEEE0706)

8. Communication Systems (AEEE08)

8.1 Basic elements of communication systems: Block diagram of analog and digital communication system, Analog and Digital Communication systems, Baseband and band pass system, Signal and noise in communication system, Definition of noise; Statistical description of noise; Types of noise; Equivalent noise bandwidth; White Gaussian noise; Signal to Noise Ratio (SNR); Bit Error Ratio (BER); Bit Error Rate (BER); Figure of Merit; Channel noise- Additive White Gaussian Noise (AWGN) channel; Effect of noise in communication system. (AEEE0801)

8.2 Analog modulation and demodulation: Amplitude Modulation (AM); Double Sideband Suppressed-Carrier (DSB-SC) modulation; Demodulators- Square law; Synchronous demodulation; Carrier recovery techniques; Single-Sideband Suppressed Carrier (SSB-SC) modulation and demodulation; Vestigial Side Band (VSB) modulation and applications, Frequency Modulation (FM) - Narrowband and Wideband FM; Phase Modulation (PM); Spectra of angle modulated signals; Pre-emphasis and de-emphasis in angle modulated system. (AEEE0802)

8.3 Digital communication and modulation: Types of Digital Modulation and Demodulation Techniques; Binary Amplitude Shift Keying (BASK); Binary Frequency Shift Keying (BFSK); Binary Phase Shift Keying (BPSK); M-ary Techniques; Quadrature Phase Shift Keying (QPSK); Quadrature Amplitude Modualtion (QAM); Error probability in PSK systems; Matched filtersource coding, Pulse Modulation Techniques, PCM, Shannon Hartley Channel Capacity theorem, Multiplexing. (AEEE0803)

8.4 Pulse modulation and coding: Pulse Amplitude Modulation (PAM) and bandwidth requirement; Pulse Code Modulation (PCM) - Encoders, Decoders, Quantization, Quantization error and Companders, Multiplexing, Differential PCM, Noise in PCM systems; Delta Modulation (DM) - Characteristic, Encoding methods, Adaptive DM and continuously variable DM, Sigma delta modulation, noise in DM systems. (AEEE0804)

8.5 Error control coding techniques: Introduction of channel coding; Hamming distance; Parity and parity coding; Block codes, Linear block code; Systematic linear block coding (coding & decoding); Cyclic code (coding & decoding); Introduction to convolution coding- code trees, trellis, state diagram and decoding method. (AEEE0805)

8.6 Data communication: R Overview of data communication and data communication networks, Parallel and serial communication, Bandwidth utilization and multiplexing, Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM), Wavelength Division Multiplexing (WDM), Network topologies, Layered architecture, TCP/IP, Open standards interconnection (OSI) Model, OSI layer functions. (AEEE0806)

9. Power Systems and Devices (AEEE09)

9.1 Power plant: Electrical Power System, Basic structure of power system, Generation of Electrical Power Thermal Power Plant, Hydro Power Plant, Nuclear Power Plants, Solar Photovoltaic System, Wind Energy Conversion Systems, Tidal power plant, Geothermal power plants, Fuel Cells, Energy Storage Systems (AEEE0901)

9.2 Transmission and distribution of electrical power: Electric supply system, various systems of power transmission, economic choice of conductor size, economic choice of transmission voltage, mechanical design of overhead lines: conductor materials, line supports, Insulators, corona, right of way, distribution systems, classification of distribution systems, load curve and load duration curve, load factor, demand factor, connection schemes of distribution systems, interference between power and communication lines, power line carrier communication. (AEEE0902)

9.3 Protection and control of electrical power system: Principles of power system protection, fuse and its operation, Miniature Circuit Breaker and its operation, Power circuit breaker operation and types, relays and their types, Protection schemes for generators, transformers and transmission lines, earthing for

electrical system, surge protection device, Control of Electrical Power System, blackouts and load shedding, Supervisory Control and Data Acquisition System , Energy Management System, Smart Grid. (AEEE0903)

9.4 Residential and industrial electrification: Service mains, types of distribution systems in buildings, Types of electrical wiring, Electrical layout drawing, load estimation and distribution board plan for a residential building, types of industrial load and their power supply requirements, tariffs, electrical energy conservation in buildings and industries. (AEEE0904)

9.5 Power electronics: Thyristor, Silicon Controller Rectifier, Diac, triac, Uninterrupted Power Supply, Switched Mode Power Supply, Dc-dc converter, Inverter. (AEEE0905)

9.6 Power system analysis: Fault Analysis, Load flow analysis, Power system stability. (AEEE0906)

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)