Nepal Engineering Council Registration Examination

Electronics, Communication and Automation Engineering

(Code: AEaE)

Chapters 1-4 are fundamentals/principles of concepts in Electronics and Communication engineering and automation; 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. Concept of Basic Electrical and Electronics Engineering (AExE01)

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 Semiconductor devices: Semiconductor diode and its characteristics, BJT Configuration and biasing, small and large signal model, working principle and application of MOSFET and CMOS. (AExE0104)

1.5 Signal generator: Basic Principles of Oscillator, RC, LC and Crystal Oscillators Circuits. Waveform generators. (AExE0105)

1.6 Amplifiers: Classification of Output Stages, Class A Output Stage, Class B Output Stage, Class AB Output Stage, Biasing the Class AB Stage, Power BJTs, Transformer-Coupled Push-Pull Stages, and Tuned Amplifiers, op-amps. (AExE0106)

2. Digital Logic and Microprocessor (AExE02)

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

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

2.3 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)

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

2.5 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. Introduction to Direct Memory Access (DMA) and DMA Controllers. (AExE0205)

2.6 Interrupt operations: Interrupt, Interrupt Service Routine, and Interrupt Processing. (AExE0206)

3. Programming Language and Its Applications (ACtE03)

3.1 Introduction to C programming: C Tokens, Operators, Formatted/Unformatted Input/output,

Control Statements, Looping, User-defined functions, Recursive functions, Array (1-D, 2-D, Multi-dimensional), and String manipulations. (ACtE0301)

3.2 Pointers, structure and data files in C programming: Pointer Arithmetic, Pointer and array, passing pointer to function, Structure vs Union, array of structure, passing structure to function, structure and pointer, Input/output operations on files, and Sequential and Random Access to File. (ACtE0302)

3.3 C++ language constructs with objects and classes: Namespace, Function Overloading, Inline functions, Default Argument, Pass/Return by reference, introduction to Class and object, Access Specifiers, Objects and the Member Access, Defining Member Function, Constructor and its type, and Destructor, Dynamic memory allocation for objects and object array, this Pointer, static Data Member and static Function, Constant Member Functions and Constant Objects, Friend Function and Friend Classes. (ACtE0303)

3.4 Features of object-oriented programming: Operator overloading (unary, binary), data conversion, Inheritance (single, multiple, multilevel, hybrid, multipath), constructor/destructor in single/multilevel inheritances. (ACtE0304)

3.5 Pure virtual function and file handling: Virtual function, dynamic binding, defining opening and closing a file, Input / Output operations on files, Error handling during input/output operations, Stream Class Hierarchy for Console Input /Output, Unformatted Input /Output Formatted Input /Output with ios Member functions and Flags, Formatting with Manipulators. (ACtE0305)

3.6 Generic programming and exception handling: Function Template, Overloading Function Template, Class Template, Function Definition of Class Template, Standard Template Library (Containers, Algorithms, Iterators), Exception Handling Constructs (try, catch, throw), Multiple Exception Handling, Rethrowing Exception, Catching All Exceptions, Exception with Arguments, Exceptions Specification for Function, Handling Uncaught and Unexpected Exceptions. (ACtE0306)

4. Computer Organization and Embedded System (ACtE04)

4.1 Control and central processing units: 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. (ACtE0401)

4.2 Computer arithmetic and memory system: Arithmetic and Logical operation, The Memory Hierarchy, Internal and External memory, Cache memory principles, Elements of Cache design - Cache size, Mapping function, Replacement algorithm, write policy, Number of caches, Memory Write Ability and Storage Permanence, Composing Memory. (ACtE0402)

4.3 Input-Output organization and multiprocessor: Peripheral devices, I/O modules Input-output interface, Modes of transfer Direct Memory access, Characteristics of multiprocessors, Interconnection Structure, Inter-processor Communication and synchronization. (ACtE0403)

4.4 Hardware-Software design issues on embedded system: Embedded Systems overview, Classification of Embedded Systems. Custom Single-Purpose Processor Design, Optimizing Custom Single-Purpose Processors, Basic Architecture, Operation and Programmer's View, Development Environment. Application-Specific Instruction-Set Processors. (ACtE0404)

4.5 Real-Time operating and control system: Operating System Basics, Task, Process, and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Synchronization, Device Drivers, Open-loop and Close-Loop control System overview, Control. (ACtE0405)

4.6 Hardware descripts language and IC technology: VHDL Overview, Overflow and data representation using VHDL. Design of combinational and sequential logic using VHDL. Pipelining using VHDL. (ACtE0406)

5. Concept of Computer Network and Network Security System (ACtE05)

5.1 Introduction to computer networks and physical layer: Networking model, Protocols and Standards, OSI model and TCP/IP model, Networking Devices (Hubs, Bridges, Switches, and Routers) and Transmission media. (ACtE0501)

5.2 Data link layer: Services, Error Detection and Corrections, Flow Control, Data Link Protocol, Multiple access protocols, LAN addressing and ARP (Address Resolution Protocol), Ethernet, IEEE 802.3(Ethernet), 802.4(Token Bus), 802.5(Token Ring), CSMA/CD, Wireless LANs, PPP (Point to Point Protocol), Wide area protocols. (ACtE0502)

5.3 Network layer: Addressing (Internet address, classful address), Subnetting, Routing Protocols (RIP, OSPF, BGP, Unicast and multicast routing protocols), Routing algorithms (shortest path algorithm, flooding, distance vector routing, link state routing) Routing Protocols (ARP, RARP, IP, ICMP), and IPv6 (Packet formats, Extension headers, Transition from IPv4 to IPv6, and Multicasting). (ACtE0503)

5.4 Transport layer: The transport service, Transport protocols, Port and Socket, Connection establishment & Connection release, Flow control & buffering, Multiplexing & de-multiplexing, Congestion control algorithm (ACtE0504)

5.5 Application layer: Web (HTTP & HTTPS), File Transfer (FTP, PuTTY, Win SCP), Electronic Mail, DNS, P2P Applications, Socket Programming, Application server concept, and Concept of traffic analyzer (MRTG, PRTG, SNMP, Packet tracer, Wireshark). (ACtE0505)

5.6 Network security: Types of Computer Security, Types of Security Attacks, Principles of cryptography, RSA Algorithm, Digital Signatures, securing e-mail (PGP), Securing TCP connections (SSL), Network layer security (IPsec, VPN), Securing wireless LANs (WEP), Firewalls. (ACtE0506)

6. Electromagnetics and Communication System (AEiE06)

6.1 Electric field and Magnetic field: Electric field and flux density, Significance of divergence, Divergence theorem, Electric potential, potential gradient, Energy density in electrostatic field, Free and bound charges, polarization, relative permittivity, electric dipole, Electric Boundary conditions, Magnetic field intensity and flux density, Magnetic force, magnetic torque, magnetic moment, magnetic dipole, magnetization. Magnetic boundary condition. (AEiE0601)

6.2: **Wave propagation and antenna:** Displacement current, Maxwell's equations in integral and point forms. Wave propagation in lossless and lossy dielectric, Plane waves in free space, lossless dielectric, good conductor. Reflection of plane wave at normal and oblique incidence, Rectangular wave guide, Transverse electric mode, transverse magnetic mode, Antenna Radiation, Theorem and Parameters, Isotropic antenna, Omni directional antenna; Dipole, Directional antennas, Travelling wave antennas (AEiE0602)

6.3 Communication System: Basic building blocks of analog and digital communication systems, Signal and noise in communication system, Low pass and Band pass signals and systems, bandwidth of a system, distortion less transmission, the Hilbert transform and its application, Time domain expression, Frequency domain representation of AM, FM & PM signals. Types of AM & FM signals. (AEiE0603)

6.4 Data communication and information theory: Process of Analog to Digital Communication system, Source Coding, Pulse Modulation Technique, Pulse Code Modulation, Types of Quantization, Quantization Noise, Shannon Hartly channel capacity theorem. Multiplexing, Random Signal and processes, White Noise, Thermal Noise, information theory, Measure of information, line codes, pulse shaping, error control coding techniques. (AEiE0604)

6.5 Signal and system: Signal definition, Impulse response and convolution, Fourier series, Fourier Transform, Unit step, Delta, Sinc & Signum function, LTI system Continuous time Fourier series

representation, Properties of continuous time Fourier Series. Discrete time Fourier series representation, Properties of discrete time Fourier series, Continuous time Fourier transform representation, Properties. Energy spectral densities, power spectral density, discrete time Fourier transform representation and Properties. (AEiE0605)

6.6 Digital Signal Processing: Definition of the z-transform, Region of convergence, Relationship to causality. Inverse z-transform, Convolution, Parseval's theorem's-transform function H (z)-transient and steady state sinusoidal response, pole-zero relationship stability, DFT, Properties of the Discrete Fourier Transform, Multiplication of two DFTs and Circular Convolution, IIR filter design by Impulse-invariant method, IIR low pass discrete filter design, FIR filter design by Fourier approximation. FIR filters using window function. (AEiE0606)

7. Control System and IoT (AEaE07)

7.1 System Representation Techniques: Transfer function, Transfer function of physical components, Effect of feedback, Block diagram representation of circuits and dc motors, Block diagram reduction techniques, Signal flow graph and Mason's gain formula, State space representation of systems, Components to physical systems. (AEaE0701)

7.2 Control system performance: open loop and close loop control system, Proportional (P) controller, Integral (I) controller, Derivative (D) controller, PI, and PID controller, Derivative feedback controller, Effect of different controllers in steady state behavior. (AEaE0702)

7.3 Stability analysis: Effect of pole location on stability, RH criteria and stability analysis from the criteria, Absolute and Relative stability, Root Locus method. (AEaE0703)

7.4 Frequency response analysis: Frequency domain characterization, Polar plot, gain margin, phase margin and stability test on polar plot, Nyquist plot and Nyquist criteria, Bode magnitude and phase plot, Stability analysis from Bode plot. (AEaE0704)

7.5 Compensation Techniques: Effect of addition of pole and zero on stability, Compensation network, Lead compensator and lag compensator design from time response and frequency response specifications, Concept of Lag-Lead compensator (AEaE0705)

7.6 IoT: Building Blocks of IoT, hardware for IoT, Connectivity Blocks and Communication Protocols, IoT Design and Development Considerations, Security Considerations Using IoT, Security Standards and Best Practices. (AEaE0706)

8. Microprogramming and Robotics (AEaE08)

8.1 Microinstruction Sequencing: Microinstructions, Microprogrammed Control Unit, Design Considerations, Sequencing Techniques, Address Generation, LSI-11 Microinstruction Sequencing. (AEaE0801)

8.2 MICROINSTRUCTION EXECUTION: A Taxonomy of Microinstructions, Microinstruction Encoding, LSI-11 Microinstruction Execution, LSI-11 Control Unit Organization, LSI-11 Microinstruction Format

(AEaE0802)

8.3 TI8800: Microinstruction Format, Microsequencer, Registers/Counters, Stack, Control of Microsequencer, Registered ALU. (AEaE0803)

8.4 Robot-Basics: Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism,

Precision and accuracy of robot, End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation. (AEaE0804)

8.5 Robot kinematics: direct and inverse kinematics, Robot trajectories, 2D and 3D, Transformation-Scaling, Rotation, Translation Homogeneous transformation, Control of robot manipulators – Point to point, Continuous Path Control, Robot programming. (AEaE0805)

8.6 Robot Sensors: Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light, Sensors, Pressure sensors, Machine Vision and Artificial Intelligence. (AEaE0806)

9. Telecommunication and Soft Switching (AEiE09)

9.1 Telecommunication and wireless communication: History of telecommunication, Generations and future trends, Guided and unguided transmission media, Free space propagation model, Reflection, diffraction and scattering, Channel assignment and handover process, small scale multipath propagation and fading model, Rayleigh fading model. (AEiE0901)

9.2 Equalization and diversity techniques: Basic equalization, adaptive equalization, diversity method, space diversity, polarization, frequency and time diversity. (AEiE0902)

9.3 Switching systems and Traffic engineering: Digital and analog switching, concept of soft switching, Routing and Signaling, Tele traffic parameters (busy hour, grade of service, service levels, and traffic intensity). Traffic routing in wireless networks, common channel signaling, integrated services digital networks. Packet vs circuit switching for PCN, protocol for network access. (AEiE 0903)

9.4 Data communication switching techniques: taxonomy of switch network, circuit switch network, transmission phase, datagram network, routing table and destination address, virtual circuit network, ISDN Services, Spread Spectrum modulation, Multiple Access techniques. (AEiE0904)

9.5 IP switching: Ipsilon IP Switching, Flow Classification, IP Service Model, Layering in the IP Protocols, IP Packet Structure, IP Header, (AEiE0905)

9.6 Soft switching: Softswitch Architecture, IP address to Phone Number, Softswitch Management, VoIP Softswitch, Mobile VoIP, DSL Technology, xDSL family tree. (AEiE0906)

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)