

Nepal Engineering Council Registration Examination
Information Technology Engineering Syllabus (AItE)

Chapters 1-2 are fundamentals/principles of concepts in computer engineering; chapters 3-9 are related to application of engineering principles in the areas of information technology; and the last (10th) 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, 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: 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: Multiplexers, Demultiplexers, 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, Master-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 Languages and Web Technology (AItE03)

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. (AItE0301)

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. (AItE0302)

3.3. OOP fundamentals and frameworks: Features of OOP, Polymorphism, Inheritance, Abstraction, Encapsulation, Classes and Object, composition, data conversion, interface, Inline functions, Default Argument, Pass/Return by reference, Access Specifiers, Objects and the Member Access, 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, Java Virtual Machine, JDK, JRE, multithreading. (AItE0303)

3.4. Fundamentals of web technology: WWW, Internet, Web Architecture, Email Protocols (SMTP, POP, IMAP), HTTPS, HTTPS, Client and Server-side scripts, Java Script: Introduction, Operator, Control, DOM, Array, Object, Smart Form, Class and objects, jQuery: Using jQuery, element finder, events, and animations. PHP: Setup/Getting started, Operators, Control, Array, Function, String operations, Math functions, Using Regex, Session, Database Connectivity, CRUD Operation, working with files, Magic quotes, emails sent, Introduction to CMS. (AItE0304)

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. (AItE0305)

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. (AItE0306)

4. Information System and Artificial Intelligence (AItE04)

4.1. Fundamentals of information system (IS): IS Architecture, Control of IS, IS Audit, Security of IS, Security strategy, Validation and SSL certificates, Access authentication (AItE0401)

4.2. Enterprise management systems and knowledge management: Enterprise management systems (EMS), Enterprise Software: ERP/SCM/CRM, Information Management and Technology of Enterprise Software, Role of IS and IT in Enterprise Management, Enterprise engineering, Electronic organism, Future trends, DSS, operations research models, Knowledge Management, Knowledge-based Expert system, Virtual reality, Data mining, Data ware Housing, OLAP, and OLTP, Anomaly and fraud detection (AItE0402)

4.3. Implementations of and applications of information systems: Change Management, Critical Success Factors, Advanced Balanced scorecard, Web uses mining, Collaborative filtering, Recommender systems, Collective intelligence, Cloud computing technologies and their types, Map Reduce and Hadoop systems, Data management in the cloud, Information retrieval in the cloud, Link analysis in cloud setup (AItE0403)

4.4. Fundamentals of artificial intelligence (AI): Introduction and Importance of AI, AI and related fields, Applications of AI, learning, Intelligent agents, Search, Heuristics, Pruning, Evaluation Functions, Utilitarian, Decision Making, Planning, Internal Representation, Classification of Problems, Classifiers, Nearest Neighbor Methods, Training, Testing and Validation, Overfitting and Complexity. (AItE0404)

4.5. Neural network and probabilistic model: Biological neural Networks, Perceptron's, Multilayer and Recursive nets, Gradient Descent, Back Propagation, Bayes and Markov Networks, DBN's and HMM's, Genetic Algorithm. (AItE0405)

4.6. Expert system and swarm intelligence: Expert system, Feature, Characteristics, Development, Architecture, Probability-based Expert System, Expert system tools, Ant Intelligent System, Development of the Ant Colony System, Application and development of Ant colony intelligence, Particle Swarm Intelligent System (AItE0406)

5. Data Communication, Computer Network and Organization (AItE05)

5.1 Introduction to computer networks, physical layer and data link layer: Networking model, Protocols and Standards, OSI model and TCP/IP model, Networking Devices (Hubs, Bridges, Switches, and Routers) and Transmission media. 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. (AItE0501)

5.2 Network layer and transport 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). The transport service, Transport protocols, Port and Socket, Connection establishment & Connection release, Flow control & buffering Multiplexing & de-multiplexing, and Congestion control algorithm. (AItE0502)

5.3 Application layer and network security: 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). 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), Software Attacks and defenses, Virus and Firewall, Malware, mobile code and agent, DOS and DDOS Attacks (AItE0503)

5.4 Synchronization, network management, protocols and programming model: Synchronization principle and mode of operation, synchronizer circuits, sampling time recovery, frame time recovery, timing inaccuracies, and elastic stores, routing control, and flow control in network management., X.25 packet-switched networks, frame relay, Integrated services digital network, ATM services and application, ATM Layers, TCP states and its transition mechanism, UNIX socket programming, TCP and UDP communication using sockets, system calls, socket-related function prototypes, signal handling, Programming I/O multiplexing, socket options, Syslog and daemon process, synchronous and asynchronous communication, Winsock communication, network utilities(login, telnet etc) (AItE0504)

5.5 Control and central processing units: Control Memory, addressing sequencing, Computer configuration, Microinstruction Format, Arithmetic and logic Unit, Instruction formats, addressing modes, bus structure, cycle and excitation cycle, Data transfer and manipulation, RISC and CISC Pipelining parallel processing, (AItE0505)

5.6 Computer arithmetic and memory system and IO: Arithmetic and Logical operation, The Memory Hierarchy, Cache memory principles, Cache memory, cache design and cache replacement algorithm Composing Memory, I/O Programming, I/O modules Input-output interface, memory mapped I/O, Direct Memory access, Characteristics of multiprocessors, Interconnection Structure, Inter-processor Communication and synchronization. (AItE0505)

6. Computer Graphics and Multimedia System (AItE06)

6.1. Introduction of computer graphics: Overview of Computer Graphics, Graphics Hardware (Display Technology, Architecture of Raster-Scan Displays, Vector Displays, Display Processors, output device

and Input Devices), Graphics Software and Software standards, Concept of Virtual reality, Virtual Reality Components, concepts of OpenGL commands, Scan Conversion Algorithms, Area Filling Algorithm.
(AItE0601)

6.2. Two and three-dimensional transformations: 2-dimensional / 3-dimensional transformations: translation, rotation, scaling, reflection, and shear; viewing pipeline, world to screen viewing transformations, Projection, and Clipping Algorithms.
(AItE0602)

6.3. 3D Objects representation, and visible surface detections: Representing Surfaces, Polygon Surface, Surface normal and Spatial orientation of surfaces, Wireframe Representation, Blobby Objects, Parametric Cubic Curves, Spline Representation, Hermite Curves, Bezier curve, Sweep, Binary Space Partition Trees, and Octree Representation, Back Face Detection Algorithm, Depth Buffer (Z-buffer) Algorithm, A-Buffer and Scan-Line Algorithms.
(AItE0603)

6.4. Illumination models and surface rendering: Basic Illumination Models (Ambient light, Diffuse reflection, Specular reflection and Phong model), Intensity attenuation and Color consideration, Polygon Rendering Methods (Constant intensity shading, Gouraud shading, Phong Shading and Fast Phong Shading).
(AItE0604)

6.5. Introduction to multimedia: Global structure of Multimedia, Medium, Multimedia system and properties, Concepts of sound system, Image and graphics Format; Image Synthesis, analysis and Transmission; Video signal representation, Computer Video Format, Computer- Based animation, Animation Language, Methods of controlling Animation, Display of Animation, Transmission of Animation.
(AItE0605)

6.6. Data compression, user interfaces and multimedia application: Coding Requirements, Lossy Sequential DCT- based Mode, Expanded Lossy DCT-based Mode, JPEG and MPEG format, Basic user interface Design Issues, Video and Audio at the User Interface, User-friendliness as the Primary Goal, Media preparation and composition, Media integration and communication, and Media Entertainment.
(AItE0606)

7. Data Structures and Algorithm, Database System and Operating System (ACtE07)

7.1 Introduction to data structure, list, linked lists and trees: data types, data structures and abstract data types; time and space analysis of algorithms (Big oh, omega and theta notations), Linear data structure (Stack and queue implementation); Stack application: infix to postfix conversion, and evaluation of postfix expression, Array implementation of lists; Stack and Queues as list; and Static list structure, Static and dynamic list structure; Dynamic implementation of linked list; Types of Linked list: Singly Linked list, Doubly Linked list, and Circular Linked list; Basic operations on Linked list: creation of linked list, insertion of node in different positions, and deletion of nodes from different positions; Doubly linked lists and its applications, Concept of Tree, Operation in Binary tree, Tree search, insertion/deletions in Binary Tree, Tree traversals (pre-order, post-order and in-order), Height, level and depth of a tree, AVL balanced trees.
(ACtE0701)

7.2 Sorting, searching, and graphs: types of sorting: internal and external; Insertion and selection sort; Exchange sort; Merge and Redix sort; Shell sort; Heap sort as a priority queue; Big ‘O’ notation and Efficiency of sorting; Search technique; Sequential search, Binary search and Tree search; General search tree; Hashing: Hash function and hash tables, and Collision resolution technique, Undirected and Directed Graphs, Representation of Graph, Transitive closure of graph, Warshall’s algorithm, Depth First Traversal and Breadth First Traversal of Graph, Topological sorting (Depth first, Breadth first topological sorting), Minimum spanning trees (Prim’s, Kruskal’s and Round- Robin algorithms), Shortest-path algorithm (Greedy algorithm, and Dijkstra’s Algorithm)
(ACtE0702)

7.3 Introduction to data models, normalization, and SQL: Data Abstraction and Data Independence, Schema and Instances, E-R Model, Strong and Weak Entity Sets, Attributes and Keys, and E-R Diagram, Different Normal Forms (1st, 2nd, 3rd, BCNF), Functional Dependencies, Integrity Constraints and

Domain Constraints, Relations (Joined, Derived), Queries under DDL and DML Commands, Views, Assertions and Triggering, Relational Algebra, Query Cost Estimation, Query Operations, Evaluation of Expressions, Query Optimization, and Query Decomposition. (ACtE0703)

7.4 Transaction processing, concurrency control and crash recovery: ACID properties, Concurrent Executions, Serializability Concept, Lock based Protocols, Deadlock handling and Prevention, Failure Classification, Recovery and Atomicity, and Log-based Recovery. (ACtE0704)

7.5 Introduction to Operating System and process management: Evolution of Operating System, Type of Operating System, Operating System Components, Operating System Structure, Operating System Services, Introduction to Process, Process description, Process states, Process control, Threads, Processes and Threads, and Types of scheduling, Principles of Concurrency, Critical Region, Race Condition, Mutual Exclusion, Semaphores and Mutex, Message Passing, Monitors, and Classical Problems of Synchronization. (ACtE0705)

7.6 Memory management, file systems and system administration: Memory address, Swapping and Managing Free Memory Space, Virtual Memory Management, Demand Paging, Performance, and Page Replacement Algorithms, introduction to File, Directory and File Paths, File System Implementation, Impact of Allocation Policy on Fragmentation, Mapping File Blocks on The Disk Platter, File System Performance, Administration Tasks, User Account Management, Start and Shutdown Procedures. (ACtE0706)

8. Software Engineering and Object-Oriented Analysis & Design (ACtE08)

8.1 Software process and requirements: Software characteristics, Software quality attributes, Software process model (Agile Model, V-Model, Iterative Model, Prototype Model, and Big Bang Model), Computer-aided software engineering, Functional and non –functional requirements, User requirements, System requirement, Interface specification, The software requirements documents, Requirement’s elicitation and analysis, and Requirement’s validation and management. (ACtE0801)

8.2 Software design: Design process, Design Concepts, Design Mode, Design Heuristic, Architectural design decisions, System organization, Modular decomposition styles, Control styles, Reference architectures, Multiprocessor architecture, Client –server architectures, Distributed object architectures, Inter-organizational distributed computing, Real –time software design, and Component-based software engineering. (ACtE0802)

8.3 Software testing, cost estimation, quality management, and configuration management: Unit Testing, Integration testing, System testing, Component testing, Acceptance Testing, Test case design, Test automation, Metrics for testing, Algorithmic cost modeling, Project duration and staffing, Software quality assurance, Formal technical reviews, Formal approaches to SQA, Statistical software quality assurance, A framework for software metrics, Matrices for analysis and design model, ISO standards, CMMI, SQA plan, Configuration management planning, Change management, Version and release management, and CASE tools for configuration management. (ACtE0303)

8.4 Object-oriented fundamentals and analysis: Defining Models, Requirement Process, Use Cases, Object Oriented Development Cycle, Unified Modeling Language, Building Conceptual Model, Adding Associations and Attributes, and Representation of System Behavior. (ACtE0304)

8.5 Object-oriented design: Analysis to Design, Describing and Elaborating Use Cases, Collaboration Diagram, Objects and Patterns, Determining Visibility, and Class Diagram. (ACtE0305)

8.6 Object-oriented design implementation: Programming and Development Process, Mapping Design to Code, Creating Class Definitions, from Design Class Diagrams, Creating Methods from Collaboration Diagram, Updating Class Definitions, Classes in Code, and Exception and Error Handling. (ACtE0306)

9. Information Theory System and Coding

(AItE09)

9.1. Introduction of information theory and signals: Measure of information, Information source entropy, and information rate. Digital and Analog Systems, Communication System, Information Measure, Channel Capacity and Ideal Communication Systems, Coding. Properties of Signals and Noise, Fourier Transform and Spectra, Power Spectral Density and Auto-correlation Function, Orthogonal Series Representation of Signals and Noise, Fourier Series, Bandwidth of Signals. (AItE0901)

9.2. Principles of signaling and circuits: Introduction, Pulse Amplitude Modulation, Pulse Code Modulation, Digital Signaling, Line Codes and Spectra, Inter-symbol Interference, Differential Pulse Code Modulation, Delta Modulation, Time-Division Multiplexing, Packet Transmission System, Pulse Time Modulation: Pulse Width Modulation and Pulse Position Modulation. Complex Envelope Representation of Bandpass Waveforms, Representation of Modulated Signals, Spectrum of Bandpass Signals, Evaluation of Power, Bandpass Filtering and Linear Distortion, Bandpass Sampling Theorem, Received Signal Plus Noise, Classification of Filters and Amplifiers, Nonlinear Distortion, Limiters, Mixers, Up Converters, and Down Converters, Frequency Multipliers, Detector Circuits, Phase Locked Loops and Frequency Synthesizers, Direct Digital Synthesis, Transmitters and Receivers. (AItE0902)

9.3. Principles of signaling and source coding: Transmission Impairments, source coding, Shannon's Encoding algorithm, Shannon-fano Encoding Algorithm, Huffman codes, Shannon's channel capacity theorem. Signals and their classification: Periodic and non-periodic signals; Deterministic and Random signals; Energy and Power signals; Continuous and Discrete time signals, Continuous and Discrete time system, Basic system properties (AItE0903)

9.4. Impairments, error handling and compression techniques: Attenuation & Distortion, Delay Distortion, Noise & Types, interference, crosstalk. Types of error & its Detection and Correction Methods, hamming codes, checksum, cyclic redundancy codes (CRC), Convolution codes, Types of data Compression Techniques. (AItE0904)

9.5. Data link control and protocol: Flow Control: Stop - & - Wait, Sliding Window, Error Control: Automatic Repeat Request (ARQ), Stop-and Wait ARQ, Sliding Window (ARQ), Asynchronous & Synchronous Protocols and its types. (AItE0905)

9.6. Data encoding & modulation: Encoding Vs Modulation, Encoding of Digital Data as Digital Signals & its Techniques, Amplitude, Frequency, and Phase Shift Keying. Pulse Code and Delta Modulation. Analog Modulation (Amplitude, Frequency, and Phase Modulation), Digital Modulation Methods, Types and Standard Modems, Multilevel Modulation, Differential PSK, QPSK Modem, Higher-Data Rate Modems. (AItE0906)

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)