Nepal Engineering Council Registration Examination
Software Engineering Syllabus (ASoE)

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

1. Fundamentals of Information Technology   (ASoE01)

1.1 Introduction to Information Technology: Introduction, Definition, Characteristics of computer, Evolution of Computer, Block Diagram Of a computer, Generations of Computer, Classification of Computers, Applications of Computer, Capabilities and limitations of computer. (ASoE0101)

1.2 Storage system: Primary versus Secondary Storage, Data storage & retrieval methods. Primary Storage: RAM ROM, PROM, EPROM, EEPROM. Secondary Storage: Magnetic Tapes, Magnetic Disks. Cartridge tape, hard disks, Optical Disks, Compact Disks, Zip Drive, Flash Drives.(ASoE0102)

1.3 Software: Software and its needs, Types of S/W. System Software: Operating System, Utility Programs Programming Language: Machine Language, Assembly Language, High Level Language their advantages & disadvantages. Application software and its types: Word Processing, Spread Sheets Presentation, Graphics, DBMS s/w.   (ASoE0103)

1.4 Computer networks: Networking models, OSI model and TCP/IP model, Different layers of OSI and TCP/IP and their significance, Networking Devices (Hubs, Bridges, Switches, and Routers) and Transmission media, Protocols and Standards, Network security (attacks, cryptography, firewalls, etc).   (ASoE0104)

1.5 Data communication: Communication Process, Data Transmission speed, Communication Types (modes), Data Transmission Medias, Modem and its working, characteristics, Types of Networks, LAN Topologies, Computer Protocols, Concepts relating to networking.   (ASoE0105)

1.6 Business data processing: Introduction, data storage hierarchy, Method of organizing data, File Types, File Organization, File Utilities.   (ASoE0106)

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

2.1 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)

2.2 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)

2.3 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.   (ACtE0803)

2.4 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.   (ACtE0804)

2.5 Object-oriented design: Analysis to Design, Describing and Elaborating Use Cases, Collaboration Diagram, Objects and Patterns, Determining Visibility, and Class Diagram.(ACtE0805)

2.6 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.   (ACtE0806)

3. Programming Language and Its Applications (ASoE03)

3.1 Procedure and parallel programming languages: General features, Data types, Abstract Data Types (ADT), Structuring, Syntax, Semantics, User-defined functions, Recursive functions, Array (1-D, 2-D, Multi-dimensional), and String manipulations, RAM model of computation; Concurrent programming languages: Concurrency structure for message passing, loosely coupled system, shared memory, PRAM, monitor, semaphore.   (ASoE0301)

3.2 Exception handling in various languages: Exception types and Exception Handling Constructs (like try, catch, throw), Programming Events, Handling Large Databases; Special Languages.
                                                                                                                            (ASoE0302)

3.3 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.
                                                                                                                            (ASoE0303)

3.4 Object-oriented programming concepts: Classes and Objects, namespace, Function Overloading, Inline functions, Default Argument, Pass/Return by reference, Class and object, Access Specifiers, Objects and the Member Access, Polymorphism (static and dynamic), method overriding , Libraries/Packages, Interfaces., abstraction, encapsulation, data hiding, constructor , destructor, Garbage collection, Dynamic memory allocation for objects and object array, this Pointer, static Data Member and static Function, Friend Function and Friend Classes.   (ASoE0304)

3.5 Streams, file handling: 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, File Input/output with Streams. File Access Pointers, Sequential and Random Access to File.   (ASoE0305)

3.6 Templates: Function Template, Overloading Function Template, Class Template, Function Definition of Class Template, Standard Template Library (Containers, Algorithms, Iterators),
                                                                                                                            (ASoE0306)

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

4.1 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)

4.2 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).

<div align="right">(ACtE0702)</div>

4.3 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)

4.4 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)

4.5 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)

4.6 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)

5. Microprocessor, Computer, Organization, and Architecture   (ASoE05)

5.1 Programming with 8085 and 8086 microprocessors: Internal Architecture and Features of 8085 microprocessor, Instruction Format and Data Format, Addressing Modes of 8085.Internal Architecture and Features of 8086 Microprocessor. Addressing Modes of 8086, Assembly Language Programming, EXE and COM programs, Assembling, Linking and Executing, One Pass and Two Pass Assemblers.   (ASoE0501)

5.2 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.   (ASoE0502)

5.3 Interrupt operations: Interrupt, Interrupt Service Routine, Interrupt Processing in 8085, Interrupt Processing in 8086, Real and Pseudo-Parallelism, Flynn's Classification, Instruction Level, Thread Level and Process Level. Resource Allocation and Deadlock, Features of Typical Operating System.

<div align="right">(ASoE0503)</div>

5.4 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.   (ASoE0504)

5.5 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.   (ASoE0505)

5.6 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. (ASoE0506)

6. Analysis and Design of Algorithm, and Programming (System and Network) (ASoE06)

6.1 Foundations of algorithm analysis: Algorithms and its properties; basic properties of algorithms. RAM model for algorithm analysis. Concepts of Time and Space Complexity with best case, worst case, average case; Asymptotic Notations. Recurrence Relations and Uses of Recurrence Relations in Algorithm Analysis. Solving Recurrences Recursion Tree Method, Substitution Method. Application of Masters Theorem for solving recurrence relations. (ASoE0601)

6.2 Divide and conquer algorithms: Concept and applications of divide and conquer approach in algorithm design. Concept and detail description of Binary Search algorithms and its analysis. Finding Minimum and maximum element in a list of items (Min-Max algorithm) and their analysis. Merge Sort algorithm time and space complexity; Quick Sort algorithm and its analysis (Best Case, Worst Case and Average Case, Randomized Quick Sort and its analysis. Concept of Heap Data Structures (max, min). Heap Sort Algorithm and its complexity analysis. Order Statistics Concepts of Order statistics, Median order; Brute force approach for selection. Selection in Expected Linear Time and its analysis. Selection in Worst Case Linear Time algorithm and its complexity analysis. (ASoE0602)

6.3 Dynamic programming: Introduction Concepts of Dynamic Programming approach for algorithm design; Greedy Algorithm vs Dynamic Programming, Recursion vs Dynamic Programming; Elements of Dynamic Programming Approach; Concept of Matrix Chain Multiplication and its Algorithm ,examples and complexity analysis; String Editing Algorithm(edit distance problem with insertion, deletion, replace operation) and its complexity analysis ; Knapsack problem and its complexity analysis; Floyd Warshall Algorithms for all pair shortest path problem, example and its complexity analysis; Travelling Salesman Problem and its analysis; Memorization Strategy Concept of Memorization. (ASoE0603))

6.4 Loading, linker and macro processor: Basic Loader Concept, Design of Absolute loader, A simple Bootstrap Loader, Machine Dependent loader features, Relocations, Program Linking, Algorithm and Data structure for linking loader, Machine independent loader features, Automatic library Search, Loader options, Loader Design Options, Linkage Editors, Dynamic linking Bootstrap Loaders, MSDOS linker, SunOS linker. (ASoE0604))

6.5 Macro processor basic: Macro Definition and Expansion, Macro Processor Algorithm and Data Structure, Machine Independent Macro Processor Features, Concatenation of Macro Parameters, Generation of Unique labels, Conditional Macro Expansion, Keyword Macro Parameter, Macro processor Design Options, Recursive Macro Expansion, General Purpose Macro processor, Macro processor with Language Translator. MASM Macro Processor, ANSIC Macro language. (ASoE0605)

6.6 **Network Programming:** Basics concepts (Communication Protocols (TCP, IP, UDP, SCTP) and their comparisons, state transition diagrams), Sockets (UNIX, Winsock), Socket Address Structures, Byte ordering and Manipulation functions, Socket System Calls, Concurrent Servers, I/O models (blocking, non-blocking, multiplexing, signal driven, asynchronous), Socket operations, UNIX /INTERNET domain socket implementation, Winsock Architecture, Winsock DLL, Windows Socket Extension, Winsock implementation. (ASoE0606)

7. Artificial Intelligence and Neural Networks   **(ACtE09)**

7.1 Introduction to AI and intelligent agent: Concept of Artificial Intelligence, AI Perspectives, History of AI, Applications of AI, Foundations of AI, Introduction of agents, Structure of Intelligent agent, Properties of Intelligent Agents, PEAS description of Agents, Types of Agents: Simple Reflexive, Model Based, Goal Based, Utility Based; and Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent. (ACtE0901)

7.2 Problem solving and searching techniques: Definition, Problem as a state space search, Problem formulation, Well-defined problems, Constraint satisfaction problem, Uninformed search techniques (Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Bidirectional Search), Informed Search (Greedy Best first search, A* search, Hill Climbing,

Simulated Annealing), Game playing, Adversarial search techniques, Mini-max Search, and Alpha-Beta Pruning. (ACtE0902)

7.3 Knowledge representation: Knowledge representations and Mappings, Approaches to Knowledge Representation, Issues in Knowledge Representation, Semantic Nets, Frames, Propositional Logic(PL) (Syntax, Semantics, Formal logic-connectives, tautology, validity, well-formed-formula, Inference using Resolution), Predicate Logic (FOPL, Syntax, Semantics, Quantification, Rules of inference, unification, resolution refutation system), Bayes' Rule and its use, Bayesian Networks, and Reasoning in Belief Networks. (ACtE0903)

7.4 Expert system and natural language processing: Expert Systems, Architecture of an expert system, Knowledge acquisition, Declarative knowledge vs Procedural knowledge, Development of Expert Systems, Natural Language Processing Terminology, Natural Language Understanding and Natural Language Generation, Steps of Natural Language Processing, Applications of NLP, NLP Challenges, Machine Vision Concepts, Machine Vision Stages, and Robotics. (ACtE0904)

7.5 Machine learning: Introduction to Machine Learning, Concepts of Learning, Supervised, Unsupervised and Reinforcement Learning, Inductive learning (Decision Tree), Statistical-based Learning (Naive Bayes Model), Fuzzy learning, Fuzzy Inferences System, Fuzzy Inference Methods, Genetic Algorithm (Genetic Algorithm Operators, Genetic Algorithm Encoding, Selection Algorithms, Fitness function, and Genetic Algorithm Parameters). (ACtE0905)

7.6 Neural networks: Biological Neural Networks Vs. Artificial Neural Networks (ANN), McCulloch-Pitts Neuron, Mathematical Model of ANN, Activation functions, Architectures of Neural Networks, The Perceptron, The Learning Rate, Gradient Descent, The Delta Rule, Hebbian learning, Adaline network, Multilayer Perceptron Neural Networks, Backpropagation Algorithm, Hopfield Neural Network. (ACtE0906)

8. Java Programming and Web Technology (ASoE08)

8.1 Java basics and multithreading: Virtual machines, JVM, JRE, JDK, Java OOP, Introduction to multithreading, Thread Class and Runnable Interface, Multiple Threads, Interrupting Threads, Thread Priorities, Synchronization, Deadlock, Thread Communication, Suspend, Resume and Stop Threads. Java Collection Interface, String Handling Calendar and Simple Date Fromat class, Formatting Strings, Numbers, Date and Time, Random class. (ASoE0801)

8.2 Java swing, AWT, event handling and JDBC: AWT classes, AWT Control Fundaments, Adding and removing control, responding to controls, Layout managers, Event handling mechanisms, Event classes, Event Listener Interfaces, Handling mouse and keyboard events, Handling Action Event of all components, origins of Swing, Swing is built on the AWT, Swing Features, The MVC connection, Swing Components and containers (ASoE0802)

8.3 J2EE, servlet programming and JSP programming: Core J2EE Technologies, Enterprise Application Architecture, J2EE Application Servers, GET and POST Request, Server Side of the Web Application, Web Container, Servlet Technology, Deployment Descriptor, Steps for writing a servlet, Session Management, Request dispatching, JSP Basics, and Java Beans in JSP .(ASoE0803)

8.4 Introduction to web technology: Introduction, History, Client Server Architecture, Web Site Design, HTML5 Tags, CSS 3, Responsive design, and Browser compatibility, XML, DTD, XSTL, XHTML, Principle of Cryptography, Authentication, Encryption/Decryption, Digital Certificates, Digital signature, Secure Socket Layer, VPN. (ASoE0804)

8.5 Client and server-side scripting: 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 Regx, Exception handling. Class and objects, inheritance, polymorphism, Session, Database Connectivity, CRUD Operation, working with files, garbage collection, Magic quotes, send receive emails, Introduction to CMS. (ASoE0805)

8.6 JDBC: Basics of JDBC, Database Drivers, JDBC Drivers, JDBC API, Statement and its types, result set, metadata and CRUD operations. (ASoE0806)

9. Real Time Systems, Distributed Systems, Cloud Computing   (ASoE09)

9.1 Introduction to real time system and real time scheduling: Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.   (ASoE0901)

9.2 Resources sharing and real time communication: Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority- Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Module Resources, Controlling Concurrent Accesses to Data Objects. Basic Concepts in Real time Communication, Soft and Hard RT Communication systems, Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols.   (ASoE0902)

9.3 Introduction to distributed systems and cloud computing: Characteristics, Advantages and Disadvantages of Distributed System, Models of Distributed System, Resource Sharing and the Web Challenges, different types of Distributed System: Grid, Cluster, Cloud; Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.   (ASoE0903)

9.4 Distributed file system and CORBA: Communication between distributed objects, Remote Procedure Call, Events and Notifications, DFS, File Service Architecture, Sun Network File System, Name Services and DNS, Directory and Discovery Services, Comparison of Different Distributed File Systems, Heterogeneity in Distributed Systems, Middleware, Objects in Distributed Systems, The CORBA approach, CORBA services.   (ASoE0904)

9.5 Virtualization, cloud architecture, services and storage and cloud security: Introduction to Virtualization Technology – Load Balancing and Virtualization, Understanding Hypervisor, Seven Layers of Virtualization, Types of Virtualization, Server, Desktop, Application Virtualization, Cloud Computing Reference Architecture, Public, Private and Hybrid Clouds, IaaS, PaaS, SaaS, Architectural Design Challenges, Cloud Storage, Inter Cloud Resource Management, Resource Provisioning Methods, Security Overview, Cloud Security Challenges, Data Security, Application Security, Virtual Machine Security, cloud Infrastructure security: network, host and application level, aspects of data security, provider data and its security, Key privacy issues in the cloud. (ASoE0905)

9.6 Agreement in distributed system: Basics of clock synchronization, logical and physical clock synchronization algorithms, distributed mutual exclusion, centralized, distributed and token based distributed mutual exclusion algorithms, fault-tolerant system, replication and its types. (ASoE0906)

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)