Nepal Engineering Council Registration Examination

Mechatronics Engineering Syllabus(AMtE)

Chapters 1-4 are fundamentals/principles of concepts in mechatronics; 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 Mechatronics *(AMtE01)*

1.1. Basic electrical engineering: Electrical circuit and network theorem, AC Fundamentals, Three phase systems, AC Machines, DC motors and generators, Armature reaction and commutation, Vector diagram and voltage regulation, Alternator excitation, Parallel operation of alternators. ***(AMtxE0101)***

1.2. Electronic Devices: Passive/ Active components, types, operation, characteristics and application, Transistor biasing and stabilization, Oscillators, Rectifiers, Filters and regulators, Amplifier, relay circuit. ***(AMtE0102)***

1.3. Digital Electronics and Application of IC: Logic gates, Arithmetic circuits, Multiplexers, Flip-flops, Latches, Registers and applications, Different types of counters and applications, Classification of A/D and D/A Converters, Classification of ICs, Operational amplifier and applications, Timers and phase locked loops (PLL), The 555 timer IC, Multi-vibrator using the 555 timer IC. ***(AMtE0103)***

1.4. Kinematic and Dynamics of Machinery: Rigid body dynamics , Kinematic link, chain and inversion, Types of joints, Belts, chain and gear drives, Cam & follower, Law of gearing, Gear types, Interference in gears, Gear train, Balancing of rotating mass, Vibration (linear, forced, free vibrations, torsional vibration). ***(AMtE0104)***

1.5. Thermodynamics and Heat Transfer: Laws of thermodynamics, Heat pump, Carnot cycle, Rankine cycle, Fourier law of heat conduction, Steady heat conduction in plane, composite walls, cylinders and spheres, One dimensional transient heat conduction, Natural and forced heat convection, Radiation heat transfer, Pool and flow boiling, Types of heat exchangers, Overall heat transfer coefficient. ***(AMtE0105)***

1.6. Manufacturing Process: Casting and its types, Molding types, Core making, Injection and blow molding, Thermoforming, Hot and cold working of materials, Sheet metal operation, Tube forming, Embossing and coining, Theory of metal cutting, Cutting tools and cutting tool materials, Machine tools, Welding types, Brazing and soldering, Unconventional machining process, Electrical discharge machining, Electron beam machining, 3D printing, Laser cutting. *(AMtE0106)*

2. Hydraulic and Pneumatic System and Devices *(AMtE02)*

2.1. Fluid Power Systems and Fundamentals: Types and application of fluid power system, Classification and properties of hydraulic fluids, Basics of hydraulics, Pascal's Law, Continuity equation, Reynolds transport theorem, Steady and unsteady flow, Momentum equation, Laminar and turbulent flow, Non-dimensional numbers, Losses in pipes, valves and fittings. ***(AMtE0201)***

2.2. Hydraulic System and Components: Sources of hydraulic power, Pump theory, Classification of pumps, Performance of pumps, Cavitation in centrifugal pump, Linear hydraulic actuators, Construction of hydraulic cylinders, Cylinder cushioning and buckling, Classification of hydraulic cylinders, Hydraulic rotary actuators, Hydraulic motors, Bent-axis axial piston motors, Vane motors, Gear motors,. *(AMtE0202)*

2.3. Design of Hydraulic Circuits: Hydraulic circuit diagram, Hydraulic control valves and types, Flow characteristics of spool valves, Flow forces acting on the spool, Different types of check

valves, Flow control valves, Three way flow control valves, Flow dividers, Types of hydraulic accumulators, Hydraulic shocks, Hydraulic spring, Intensifier and its application, Hydraulic filters and pressure switches, Pressure gauge isolators, Hydraulic circulatory systems. ***(AMtE0203)***

2.4. Pneumatic System and Components: Effect of air compressibility and viscosity, Elements of pneumatic system, Principles of pneumatic control, Basic pneumatic circuits, Air compressors, Pneumatic reservoirs, Air filters, Air lubricators, Pneumatic control valves, Quick exhaust valves, Directional control valves, Non-return valves, Logic valves, Time delay valves, Pressure sequence valves. *(AMtE0204)*

2.5. Design of Pneumatic Circuits: Pneumatic circuit diagram, Flow amplification and inversion, Memory function, Pneumatic logic circuit for various applications, Displacement step diagram, Speed control circuits, Hydro-pneumatic circuit, Sequential circuit design for various applications. ***(AMtE0205)***

2.6. Development of Circuit for Industrial Automation: Electro-pneumatic systems, Electrical control solenoid valves, Dominant OFF and ON circuit, Electro-hydraulic system, Torque motors, Hydro-pneumatic system, Fuzzy logic controller, Programmable logic controller (PLC) in automation. *(AMtE0206)*

3. Control System *(AMtE03)*

3.2. Signals and Systems: Classification of systems, Representation of linear time invariant (LTI) system, Impulse, step and exponential response, Convolution, System stability, Classification of signals, Laplace transform and properties, Analysis of LTI system, Analysis of discrete LTI system, Gibbs phenomenon, Properties of Fourier series and transform. ***(AMtE0301)***

3.2. Modeling of Dynamic System: Mathematical modeling of mechanical systems, Transfer function of thermal, fluid and mechanical spring-mass-damper system, Signal-flow graphs of state equations, Transient response analysis, State-space modeling of system, Mathematical modeling of electrical, electromechanical, liquid-level, pneumatic system, hydraulic and thermal systems, Modeling of nonlinear system. ***(AMtE0302)***

3.3. Time Domain Analysis and Design of Control System: Modeling in time domain, Converting transfer function to state space and vice versa, Time domain performance, First-order system, Second-order system, General second-order system, System response with additional poles and zeros, Root locus and sketching root locus, Transient response design, Root locus for positive feedback system, Design with root locus, Cascade compensation in time domain. ***(AMtE0303)***

3.4. Frequency Domain Analysis and Design of Control System: Bode plot representation of frequency response, Polar plots, Stability analysis, Closed-loop transient and open loop frequency response, Relation between closed loop transient and closed loop frequency responses, Design of control system in frequency domain, Feedback compensation, Lead, lag, lead-lag network for compensation, Cascade compensation in frequency domain. ***(AMtE0304)***

3.5. Stability Analysis: Concept of stability, Necessary condition for stability, Hurwitz stability criterion, Routh stability criterion, Relative stability analysis, Nyquist stability criterion, Liapunov's stability criterion, direct method of Liapunov and linear system, Liapunov functions for nonlinear system. ***(AMtE0305)***

3.6. Process Control: Concept of process control, Analog and digital controller, Control modes, Pneumatic ON-OFF controller, Pneumatic proportional controller, Pneumatic proportional – integral (P-I) controller, Pneumatic proportional-derivative (P-D) controller, Pneumatic proportional-integral-derivative (P-I-D) controller, Hydraulic integral controller, Hydraulic proportional controller, Tuning of PID controller, Fuzzy logic controller (FLC) application, Selection and application of Programmable logic controllers (PLC). ***(AMtE0306)***

4. Sensors and Actuators *(AMtE04)*

4.1. Sensors Classification: Classification of sensors, Transducers, Characteristics of sensors,

Selection of sensors and transducers, Reliability, resolution, accuracy and precision of sensors, Sensor calibration. Performance and selection of sensers and transducers, interfacing of sensors and actuators. ***(AMtE0401)***

4.2. Displacement, Proximity, Angular Velocity, Acceleration and Strain Measurement Sensor: Types of displacement and resistive sensors, Linear and rotary potentiometer, Inductive sensors, Capacitive sensors, Digital sensors, Encoder, Non-contact type thickness measurement devices, Types of proximity sensors, Photoelectric sensor, Tachometer, Digital tachometers and Stroboscopic methods, Optical encoders, Types of accelerometer, Principle of strain gauge, Bridge circuit in strain gauge. ***(AMtE0402)***

4.3. Force, Torque, Pressure, Flow, Temperature, Light and Level Measurement Sensors: Basic methods of force measurement (strain gauge load cell, piezoelectric load cell, tactile sensor), Torque Measurement (reaction and rotary torque sensors, Torsion meter), Pressure Measurement (Aneroid barometer, manometer, bourdon tube) Flow Measurement (Pitot tube, venturi meter, orifice plate, ultrasonic flow meter, drag-force flow meter, hotwire anemometer), Temperature Measurement (Thermistor, thermocouple, Integrated circuit (IC) temperature sensor, thermos-diodes and transistors, infrared type), Light Sensor (Photo-resistor, photodiode, phototransistor, pyroelectric Sensor) Level Measurement (Bubbler method, conductivity level switch, liquid level measurement using float). ***(AMtE0403)***

4.4 Electrical Actuators: Modeling of DC motor behavior, Velocity profile optimization, Inertia matching, Servo amplifier, Speed control of DC motors, Type of stepper motors, construction and characteristics, Electrical model of energized coil, Stepper motor application and performance, Selection of motors for mechatronic application, Linear Actuators (Voice coil actuators, solenoids, relays). ***(AMtE0404)***

4.5 Hydraulic, Pneumatic and Piezoelectric Actuators: Components of hydraulic and pneumatic system, Hydraulic motors, Filter, Classification of hydraulic valves, Pressure and flow control valves, Direction control valves, Pneumatic valves, Pressure regulation, Relief valves, Pneumatic cylinders, Air motors, Modeling of a hydraulic servo system for position control, Modeling a pneumatic servo system, Piezo-effect phenomenon, Piezoelectric materials, Piezo-actuating elements, Application of piezoelectric actuators, Piezo motors (Ultrasonic motor). ***(AMtE0405)***

4.6. Selection of Actuators: Actuator bandwidth, Frequency response, Actuator range, Output torque, Torque to weight ratio, Control accessories, Power source availability and power consumption, Speed of operation, System component costs and maintenance, Performance characteristics, Tradeoff between force and displacement, or torque and speed, Control system and electronics, Industrial consideration. ***(AMtE0406)***

5. Communication *(AMtE05)*

5.1. Basics of Communication System: Electromagnetic spectrum, Signal bandwidth and power, Elements of communication systems, Communication channels and their characteristics, Mathematical models for communication channels, Modulation methods, Coding methods, Signal distortion and distortion less transmission, Equalization, Transmission loss and decibels, Power gain, Transmission loss and repeaters, Fiber optics, Ideal and real filters, Quadrature filters. ***(AMtE0501)***

5.2. Amplitude Modulation: Concept of amplitude modulation, Bandpass signals and systems, Bandpass transmission, Single-sideband AM, Principle of Double-sideband (DSB) amplitude modulation, Modulating circuits, AM signal and spectra, DSB signals and spectra, Tone modulation and phasor analysis, Principle of suppressed-sideband amplitude modulation, Demodulation of SSB AM signals, Vestigial-sideband AM, Types of AM modulator and transmitters. ***(AMtE0502)***

5.3. Frequency Modulation: Frequency spectrum of FM wave, Phase deviation and modulation index, Frequency deviation and percent modulated waves, Bandwidth requirement of angle modulated waves, Narrow band FM and wide band FM, Direct and indirect FM transmitter,

Principle and working of direct phase modulator (PM) , Relationship between FM and PM, FM demodulation, Phase lock loop FM demodulator, Comparison between AM, FM and PM. ***(AMtE0503)***

5.4. Analog Communication System: Receivers for CM modulation, Types of multiplexing system, Synchronous detection and frequency synthesizers, AM and FM radio broadcasting, Television broadcasting, Black-and-white TV signals, Color TV signals, Video signals, Monochrome transmitters and receivers, Mobile radio systems, Effect of noise on baseband, SSB AM and angle modulation. ***(AMtE0504)***

5.5. Digital Communication: Digital signals and system, Regenerative repeaters, Matched filtering, Optimal terminal filters, Equalization, Bit synchronization, PCM generation and reconstruction, PCM versus Analog Modulation, Digital modulation technique, Analog to digital and digital to analog signal conversion technique, LPC speech synthesis, Digital multiplexing, Digital subscriber lines, Integrated services digital network, Synchronous optical network, Data multiplexers, Interleaving, Syndrome decoding, Convolutional encoding, Decoding methods, Data encryption, Spectral analysis of bandpass digital signals. ***(AMtE0505)***

5.6. Antennas, Wave Propagation and Wireless Communication: Antenna parameters, Types of antenna, Wave propagation and types, Cellular system, Frequency reuse, Co-channel and adjacent channel interference, Propagation models for wireless networks, Types of wireless networks, Wireless local area networks (WLANs), Cellular-WLAN integration. ***(AMtE0506)***

6. Signal Conditioning, Processing and Data Acquisition *(AMtE06)*

6.1. Analog Signal Conditioning: Signal conditioning process, Functions of signal conditioning equipment, DC and AC signal conditioning system, Types of analog signal conditioning elements, Comparator and waveform generator, Types of filters, Types of Voltage regulators, Non-linear analog signal processing, Multifunction converter, True RMS to DC converter, Peak detector and track and hold (T& H) circuits, Square root circuits and dividers, Phase sensitive rectifiers, Lock-in amplifier. ***(AMtE0601)***

6.2 Data Acquisition: Components of data acquisition system, Digital data acquisition system, Digital to Analog Converter (DAC), Weighted resistor DAC, R-2R ladder, DAC 0800 data sheet and features, Analog to Digital conversion (ADC) : Functional diagram, Flash, Counter, Successive approximation, Tracking, Dual slope, Flash, Dynamic range and Floating Point, Delta-Sigma, DAC specifications, Switching network, DAQ systems. ***(AMtE0602)***

6.3. Signal Processing: Elements of signal processing, Implementation of linear time-invariant systems, Discrete Fourier transform (DFT) application, Forward and reverse transform, Structure of FIR and IIR filter, Digital filters, Design of linear FIR filter by frequency sampling method, Bit-serial arithmetic, Pipelined implementation, Distributed arithmetic implementation. ***(AMtE0603)***

6.4. Data Signal Transmission: Methods of data transmission, Mechanical transmission, Hydraulic transmission, Pneumatic transmission, Magnetic transmission, Electric transmission, Telemetry, General telemetering system, Electrical telemetering system, DC telemetry system, Voltage telemetering system, Current telemetering system, Position telemetering system, AC telemetry system, Pulse telemetering system, Analog pulse telemetry, Digital telemetry, Transmission channels and media, Wire line channels, Radio channels, Microwave channels, Power line carrier channels, Multiplexing in telemetering system. ***(AMtE0604)***

6.5 Digital Interface in Measurement: Sampling theorem, Quantization noise, Dithering, IEEE-488 Instrumentation Bus (GPIB) structure and operation, Serial data communication link, RS-232C and D interfaces, RS-422, RS-423 and RS-485 interfaces, Universal Serial Bus (USB), IEEE 488 General Purpose Interface Bus (GPIB), CAMAC (IEEE-583) Modular Instrumentation Standard, Data transmission Fiber Optic Cable (FOC), Semiconductor sources and detectors used in FOC data transmission. *(AMtE0605)*

6.6. Data Presentation and Display: Electrical indicating instruments, Digital instruments,

Electronic counters, RS flip-flop, T and RST flip-flops, Decade counter, Digital display methods, Seven segmental display, Fourteen segmental display, Dot Matrices, Rear projection display, Nixie tube, Light emitting diode, Liquid crystal display, Segmental gas discharge display, Decade counter assembler, Decimal decoders, Diode, TTL logic, BCD to 7 segment converter, BCD to Dot matrix converter, Cathode ray tube (CRT) display, Plasma display, LED display, LCD display, Quantum dot display (QLED), Resolution and sensitivity of digital meters, Printers, Magnetic recording. ***(AMtE0606)***

7. Design of Machine Elements *(AMtE07)*

7.1. Introduction: Machine design procedure, Selection of materials, Mechanical properties of different ferrous and non-ferrous metals, Effect of impurities on different ferrous metals, Iron-carbon diagram, Heat treatment, Casting, Forging, Interchangeability, Limit, fits and tolerance, Surface roughness and measurement, Free-body diagram, Force estimation of machine elements. ***(AMtE0701)***

7.2. Stress in Machine Parts: Load, stress and strain, Bearing stress, Stress-strain diagram, Poisson's ratio, Torsional shear stress, Stress in beams and pipes, Principal stress and planes, Theories of failure, Eccentric loading, Shear stress in beams, Fatigue and endurance limit, Load factor, Size factor, Factor of safety, Stress concentration, Stress analysis. ***(AMtE0702)***

7.3. Different Joints and Design: Design of different pipe joints, Types of riveted joints and riveting, Failure of riveted joint, Different type of welding and welded joints, Strength of welded joints, Common types of screw fastening, Stresses in screwed fastening, Design of nut and bolts, Design of socket and spigot cotter joint, Design cotter joint, Design of knuckle joint, Design of turn buckle, Design of different keys, Design of screw jack. ***(AMtE0703)***

7.4. Design of Shaft, Columns, Coupling, Spring, Flywheel, and Clutch: Types of shafts, Design of shaft, Failure of a column, Rankine and Johnson's formula for columns, Design of piston rod, Types of shaft couplings, Design of sleeve and coupling, Types of spring, Design of spring, Design of flywheel, Types of clutches, Design of disc clutch, cone clutch, and centrifugal clutch. *(AMtE0704)*

7.5 Design of Different Type of Bearing: Classification of bearing, Properties of lubricants, Bearing characteristics number, Design of journal bearing, bushed bearing and thrust bearing, Types of rolling contact bearing, Types of radial and thrust ball bearing, Selection of ball bearing, Bearing life, Dynamic load rating of rolling contact bearing, Standard designation of ball bearing, Lubrication of ball and roller bearing. ***(AMtE0705)***

7.6 **Design of Gears**: Design of gear drive, Static and dynamic tooth load, Design of spur gear, Design of shaft for spur gear, Helical gear and design, Strength of helical gears, Classification of bevel gears, Design of bevel gear, Strength of bevel gear, Design of shaft for bevel gear, Types of worm gear, Design of worm gearing, Strength of worm gear, Forces acting on worm gear. ***(AMtE0706)***

8. Microprocessor, Microcontroller and Programming *(AMtE08)*

8.1. 8085 Microprocessor: Characteristics and application of microprocessor, Microprocessor architecture and its operation, Pin configuration of 8085 microprocessor, Timer and counters, Read and write bus timing of 8085 microprocessor, Power supply and clock frequency, Serial I/O ports, Addressing Mode of 8085, Interfacing I/O devices, Address decoding, Interfacing output displays, Interfacing input devices, Memory-Mapped I/O, I/O address decoding with NAND and Block Decoders (8085 & 8086), Memory address decoding with NAND, Block and PROM decoders (8085 & 8086), Parallel interface modes, Serial interface and interface standards (RS232, RS423, RS422, USB), Direct memory access (DMA) and DMA controllers. *(AMtE0801)*

8.2. Programming with 8085 Microprocessors: Instruction format and data format, Addressing modes of 8085, Intel 8085 instruction set, Arithmetic and logical operations, Array and table

processing, Multiplication and division, Writing assembly language programs, Debugging a program, Looping, Counting and Indexing, 16-Bit arithmetic instructions, Logical operation (Rotate, Compare), Debugging counter and time-delay programs, Stack and subroutines, Restart, conditional call and return instructions, BCD to Binary conversion and vice-versa, BCD to seven segment LED code conversion, Binary to ASCII and ASCII to Binary code conversion, BCD addition, BCD subtraction, multiplication and division. ***(AMtE0802)***

8.3. Programming with 8086 Microprocessor: Internal architecture and features of 8086 microprocessor, BIU and EU and components, EU and BIU operations, Segments and offset address, Addressing modes of 8086, Assembly language programming, EXE and COM programs, Assembling , linking and executing, One pass and two pass assemblers, Keyword and video services, Various programs in 8086. ***(AMtE0803)***

8.4. Interfacing Peripherals (I/O) and Applications: Interrupt processing sequence, Interrupt service routine and processing in 8085, Interrupt processing in 8086, The 8155 programmable peripheral interface, The 8279 programmable interface, The 8255A programmable peripheral interface, Bidirectional data transfer between two microcomputers, The 8254 programmable interval timer, The 8259 programmable interrupt controller, Direct memory access (DMA) with 8237 DMA controller, Software controlled asynchronous serial I/O, The 8085 serial I/O lines, Hardware controlled serial I/O programmable chips, Microprocessor applications, Interfacing multiplexed displays and liquid crystal displays, Interfacing a matrix keyboard, Memory design, Designing a single board microcomputer. *(AMtE0804)*

8.5. Microcontroller: Difference between microprocessor and microcontroller, Components of microcontroller, Arithmetic and Logic Unit (ALU), Register, Oscillators, TTL integrated circuit, CMOS integrated circuit, Connection of peripherals, Timers, The 68HC11/68HC12 Microcontroller, PIC Microcontroller families, Memory in Microcontrollers, I/O ports, Programming in Microcontroller. ***(AMtE0805)***

8.6 Programmable Logic Controller: Basic structure and architecture, Types of PLC, PLC configuration, Selection criteria for PLC, PLC communication with PC, I/O devices, I/O processing, Binary system, Octal and hexadecimal, Binary arithmetic, PLC Programming, Need for HMI in industrial automation, Types of HMI, Configuration of HMI, PLC networking, Networking standards, Protocols, Field bus, Process bus and Ethernet, PLCs versus Computer, Programs for Temperature control, Valve sequencing, Conveyer belt control, Control of a process. *(AMtE0806)*

9. Design of mechatronic System and Robotics *(AMtE09)*

9.1. **Mechatronic System**: Emerging areas of Mechatronics, Classification of Mechatronics, Basic building blocks of mechatronic system, Mechatronic key elements, Examples of Mechatronic Systems, Mechatronics in home, office and industry automation, Scope of Mechatronics. ***(AMtE0901)***

9.3. Mechanical, Electrical and Electronic Engineering in Mechatronics: Mechanism used in mechatronics, Assembly techniques, Hydraulic and pneumatic actuators, Micro actuators, Piezoelectric actuators, Electrical systems, Electrical actuators, Brushless permanent magnet DC motor and interfacing, Stepper motor and interfacing, AC servomotor, Drive selection and its applications, Electronic system, Micro- Electro-Mechanical system (MEMS). ***(AMtE0902)***

9.3. Mechatronic Design Process: Recognition of the need and problem analysis, Conceptual design and preparation of functional specification, First principle modular mathematical modeling, Selection of sensor, actuators and drive system, Detailed modular mathematical modeling, Control system design, Evaluation of design, Design optimization, Production of detailed design, Implementation of design, Prototyping, Hardware-in-loop simulation, Deployment/life cycle, Deployment of embedded software, Life cycle optimization, Traditional and Mechatronic design concepts. ***(AMtE0903)***

9.4. Robotics: Types of robots, Robot control and control components, Embedded robot controller, I/O interface, Robot drive system (hydraulic, electric drive, pneumatic drive), Types of robot

end effectors, Selection parameters of robot, Application of robots, Humanoids, Robot locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Robot sensory system, Performance, Interaction, Safety and robustness. ***(AMtE0904)***

9.5. Design of Autonomous Mobile Robot: Levels of Autonomy ,Mechanical design alternatives, Gearhead DC motors, Modified servo motors, Skid steering, Explicit steering, Design specifications, Drive motor sizing, Steering motor sizing, Gear system selection, Kinematic analysis, Mechanical considerations, Electronic circuits and interfacing, Sensors, Serial communication circuit, Robot circuitry, Motor driving circuitry, Communication strategy, Interfacing the servo steering motor, Software development, Serial communication algorithm, Data collection, Motion algorithm, Map generation. ***(AMtE0905)***

9.6. Design of Photo-polymerization based CAD Compatible stereo 3D Printer: Working principle of scanning type and projection type of 3D printer, Components of scanning and projection type printer, Laser system, Dynamic mask mirror, Optical modulator, Scanning mechanisms, Slicing, Scan path and image projection strategies, Selection of actuator for scanning mechanisms, Optical sensors and its selection criteria, Layer preparation system, Interfacing of the sensors and actuators, Data communication schemes for projection and scanning systems, System identification and controller design. ***(AMtE0906)***

10. Project Planning, Design and Implementation *(AALL10)*

10.1.**Engineering drawing and its concepts**: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, tolerance, Orthographic projection, Isometric projection/view, Pictorial views, Sectional drawing. ***(AALL1001)***

10.2. **Engineering Economics**: Interest and time value of money, Understanding of project cash flow, Basic methodologies of engineering economic analysis (Discounted payback period, NPV, IRR & MARR), Comparative analysis of alternatives, Depreciation and taxation system in Nepal. *(AALL1002)*

10.3. **Project Planning and Scheduling**: Classification of project, Project life cycle phases, Project planning process, Project scheduling (Bar chart, CPM, PERT), Resource leveling and smoothing/evaluation/controlling. *(AALL1003)*

10.4. **Project management**: Information system, Project risk analysis and risk management, Project financing, Tender and its process, Contract management. *(AALL1004)*

10.5.**Engineering Professional Practice**: Environment and society, Professional ethics, Ethical standards in engineering practice, Code of ethics for engineers, Professional practice in Nepal, Regulatory environment, Contemporary issues/problems in engineering, Occupational health and safety, Roles/responsibilities of Nepal Engineers Association (NEA). *(AALL1005)*

10.6. Engineering Professional Bodies in Nepal: Nepal Engineering Council (Acts & Regulations). *(AALL1006)*