Nepal Engineering Council Registration Examination

Aerospace/Aeronautical Engineering Syllabus (AAAE)

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

1. Basic Mechanical Engineering Concept (AMeE01)

1.1 Mechanical drawing: Machine drawing, welded joints, rivets and riveted joints, bolt, nut & screw fasteners, keyways and keyed assembly, tolerance, limits and fits, Surface finish. (AMeE0101)

1.2 Engineering materials: Mechanical properties of materials and testing, metals and alloys, fatigue of metals, creep and stress fracture of metals, corrosion and control. (AMeE0102)

1.3 Material science: Crystal structure, deformation process, solidification, phase relations and strengthening process, iron-carbon diagram, types of steel and cast iron, Polymers and Composite Materials. (AMeE0103)

1.4 Basic electrical and electronics: Charge, current, voltage, power, and energy, Current and voltage laws (Kirchhoff, Ohm), Equivalent circuits (series, parallel), AC circuits, Motors and generators, Induction machines, Transformer, Capacitors, resistors, filters, relay, integrated circuit, diodes, transistor, amplifier and oscillator. (AMeE0104)

1.5 Mechanical workshop: Safety considerations, Hand tools and machine tools, lathe, shaper, milling machine, grinding machine, Drills and drilling processes, joining and fabrication process, arc and gas welding. (AMeE0105)

1.6 Oorganization management: organization & its types, Modern management theory, leadership & communication, entrepreneurship, motivation, HRM, development of business plan, Management Information System (MIS), Technology management. (AMeE0106)

2. Engineering Thermodynamics (AMeE02)

2.1 Thermodynamics basics: Systems and Surrounding, temperature, Thermodynamics properties, State Function and Path Function, Thermodynamics equilibrium, Zeroth law, Ideal gas, Ideal gas equation, Universal Gas Constant and Characteristic Gas Constant, Specific volume & quality, Two phase system, Two phase mixture, Development of property charts and table. (AMeE0201)

2.2 1^{st} Law of thermodynamics: Conservation of mass and energy, Internal energy, Enthalpy & specific heat, Work Transfer and Heat Transfer for Isothermal, isobaric, isochoric process, adiabatic process & polytropic process; Steady and Unsteady state work and flow application. (AMeE0202)

2.3 2^{nd} Laws of thermodynamics: Kelvin Planck & Clausius Statements its equivalence, Entropy and Entropy Relations, Isentropic process & efficiency, reversible and irreversible process Heat engine, Heat pumps, Refrigerator, thermal efficiency, coefficient of performance, Carnot cycle and its efficiency. (AMeE0203)

2.4 Thermodynamic cycles: Power and Refrigeration Cycle, Vapour compression & vapour absorption cycle, Rankine cycle, Brayton cycle, Otto cycle, Diesel cycle, and their efficiency and COP. (AMeE0204)

2.5 Internal combustion engines: Working of spark ignition engines and compression ignition engine; major components and their functions, Cycle of operation in four stroke and two-stroke cycle engines. (AMeE0205)

2.6 Applied thermodynamics: Basic HVAC System, Boilers, Compressors, Refrigerants and its properties, psychometrics. (AMeE0206)

3. Fluid Mechanics and Machines (AMeE03)

3.1 Fluid properties and statics: Fluid and Solid, Continuum, No-slip condition, Lagrangian and Eularian approach, Control Volume, Viscosity, Newtonian and non-Newtonian fluids, Surface tension, Pressure, Pressure Measurement, Force on a plane. (AMeE0301)

3.2 Kinematics: Types of fluid flow, Steady flow, Uniform Flow, Compressible Flow, Rotational Flow, Laminar and Turbulent Flow, Reynolds Number, Stream Function, Potential Function, Vorticity, Circulation. (AMeE0302)

3.3 Fluid flow equations: Continuity equation, Euler Equation, Bernoulli's Equation, Application of Bernoulli's Equation, Momentum Equation, Dimensional analysis & Similitude. (AMeE0303)

3.4 Laminar flow: Laminar flow in a pipe, Laminar flow between parallel plates, Major losses, Minor losses, Boundary layer, Boundary layer thickness, Laminar and Turbulent Bound Layer Flow, Flow separation (AMeE0304)

3.5 Turbines: Classification of turbines, working principle, components and their functions, turbine governors, Cavitation, Performance Curves, Draft Tube. (AMeE0305)

3.6 Pumps: Classification of pump, working principle, components and their functions, Priming, Net Positive Suction Head (NPSH), Performance Curves. (AMeE0306)

4. Engineering Mechanics and Strength of Material (AMeE04)

4.1 Applied mechanics: Concept of Particles, rigid and deformable bodies, Concept in Statics and Static Equilibrium, Forces acting on particle and rigid body, Friction, Newton's law of motion, Newton's Law of Gravitation, Work Energy Theorem, Impulse Momentum Principle. (AMeE0401)

4.2 Theory of elasticity: Stress, Strain, Hook's Law, Modulus of elasticity, Thermal stress, longitudinal strain, Lateral strain, Poisson's ratio, volumetric strain, bulk modulus, strain energy and impact loading. (AMeE0402)

4.3 Strength of materials: Centre of Gravity, Centroid, mass & area moment of inertia, polar moment of inertia, shear force and bending moment, Deflection of Beam, Analysis of Truss, Torsion of Shaft. (AMeE0403)

4.4 Theory of machines: Degree of Freedom, linkage mechanism (4R, 3R-1P, 2R-2P), kinematics of motion, kinetics of motion, velocity in mechanism, acceleration in mechanism, Force in mechanism, mechanisms with lower pairs. (AMeE0404)

4.5 Mechanism: gyroscopic couple & processional motion, governor, flywheel, balancing of mass, cam and follower mechanism, SHM, Cyclodial Motion, Uniform motion, & Uniform acceleration and retardation motion, belt, rope and chain drives, gear & gear trains. (AMeE0405)

4.6 Mechanics of solid: Analysis of Deformable body, stress on deformable body, Determinate and indeterminate structures, Thick Wall and Thin Wall Cylinder, Torsion of Non-circular sections. (AMeE0406)

5. Fundamentals of Aerospace Engineering (AAAE05)

5.1 Introduction: Vector operators and theorems, streamline, streakline and pathline, laminar and turbulent boundary layers, flow conservation laws, International standard atmosphere conditions; layers

of atmosphere, Kármán line, Kepler's laws of planetary motion, distinctions between aircraft and spacecraft. (AAAE0501)

5.2 Airfoil and wing design: Airfoil nomenclature, critical Mach number, drag divergence, supercritical airfoil, high lift devices, area rule, twist, taper, sweep, dihedral, Mean aerodynamic chord. (AAAE0502)

5.3 Aircraft classification: Classification based on propulsion system, air breathing and non-air breathing engines, wing geometry, fuselage, landing gear and empennage; basic flight principles and control surfaces. (AAAE0503)

5.4 Basic aerodynamics: Elementary flows, Kutta-Joukowski theorem, d'Alembert's paradox, downwash, , lift-curve slope, drag polar, thin airfoil theory, Prandtl's lifting line theory, boundary layer effects, classification of drags. (AAAE0504)

5.5 Finite wing design: Aerodynamic coefficients, aerodynamic centre, centre of pressure, relationship between aerodynamic centre and centre of pressure, aerodynamic twist and geometric twist. (AAAE0505)

5.6 Basic flows: Flow over wedges and cones, flow over blunt body, basic compressible aerodynamics, shock waves, Prandtl-Meyer expansion waves, viscous flow properties. (AAAE0506)

6. Aircraft Systems and Maintenance (AAAE06)

6.1 Ice, rain, and fire protection systems: De-icing, anti-icing, ground de-icing system, fire zone classification detection and remedies, smoke detection system. (AAAE0601)

6.2 HydraulicPneumatic, lavatory and potable water systems: Different components and working principle, lavatory, hydraulic, pneumatic and potable water system. (AAAE0602)

6.3 Landing gear and fuel systems: Major components of landing gear, application of various landing gear systems and brakes, emergency extension of landing gears, types of fuel and fuel tanks.

(AAAE0603)

6.4 Maintenance: Maintenance types and, manufacturer documentation, airline generated documentation, line and hangar maintenance, fault monitoring and diagnosis. (AAAE0604)

6.5 Aviation organization certifications: Aircraft maintenance organization certification, continuing airworthiness organization certification, aircraft maintenance license procedure, aircraft design organization certification, aircraft maintenance training organization certification. (AAAE0605)

6.6 Regulations and safety: International aviation regulators, organizations and association, quality assurance/control, reliability and maintenance safety, occupational health and safety, flight operation requirement, airlines operation certificate requirement, civil aviation regulations. (AAAE0606)

7. Aircraft and Structure (AAAE07)

7.1 Introduction: Airframe components, monocoque and semi-monocoque structures, wing-box structure, thick box-beam structure, integrally stiffened panels, loads acting on aircraft components: wing, fuselage, empennage, and landing gears. (AAAE0701)

7.2 Continuum mechanics: Truss, beams, columns, shells and their applications, Mohr's circle for plane stress, thin plate bending, buckling and twisting, principle stress and strain. (AAAE0702)

7.3 Design of airframe: Shear centre, neutral axis, radial stress, hoop stress, failure stresses in plates and stiffened panels, integrated design techniques, roles of skin, spar, longerons and frames, composite airframe design. (AAAE0703)

7.4 Structural analysis: Structural analysis of airframe, V-n diagram, shear flow analysis, aeroelasticity and flutter analysis, computational tools for structural analysis. (AAAE0704)

7.5 Aircraft/Spacecraft design criteria: Infinite life, safe life, fail safe, damage tolerance and retirement, damage tolerance inspections standard dimensions of CubeSats, classification of satellites based on size and weight. (AAAE0705)

7.6 Airframe response: Bending, shear, and torsion of thin-walled structures, simplified structural representation of aircraft components, aircraft structural response while on air and ground, effects of temperature. (AAAE0706)

8. Aircraft Materials and Avionics (AAAE08)

8.1 Introduction: Material selection for design, common materials used in aircraft industry, basics of human machine interface, fly-by-wire, radio wave propagations, satellite communications, flight management and autopilot systems. (AAAE0801)

8.2 Metallurgy: Crystal geometry, Millers indices, Schmid's law and Fick's laws, Material properties, material processing; (AAAE0802)

8.3 Materials and alloys: High performance non-ferrous alloys, high temperature super-alloys, application of high-temperature alloys, basics of composite materials: composition, types of composite materials based on reinforcement and matrix. (AAAE0803)

8.4 Aircraft instruments and electrical systems: Altimeter and its types, VSI, ASI, horizontal situation indicator, head down display, , , heads up display Engine parameters indicating systems, aircraft batteries, aircraft external ground power, circuit protection system. (AAAE0804)

8.5 Navigation and communication systems: Doppler navigation system, inertial navigation system and global positioning system, automatic direction finder, , non-directional beacon, instrument landing system and distance measuring equipment, VHF and HF communications, VHF omnidirectional range, GNSS. (AAAE0805)

8.6 Transponder and radar: Secondary surveillance radar, TCAS system, weather avoidance radar, automatic dependent surveillance-broadcast systems. (AAAE0806)

9. Aircraft Propulsion, Performance, Stability and Design (AAAE09)

9.1 Engines: Types of aircraft engines, components of aircraft engines, Brayton cycle and thermodynamic performance, basics of aero-thermodynamics, efficiencies (isentropic, polytropic), engine component performance analysis, spacecraft propulsion systems, types of rocket engines. (AAAE0901)

9.2 Propulsion system design: Combustion chamber geometry and types, combustion process, combustion chamber performance and flame stabilization, compressor and turbine geometry, compressor and turbine staging. (AAAE0902)

9.3 Flight performance: Aircraft performance for different phases of flight, types of control surfaces and trim tabs, types of flaps, control systems input commands and output responses, Breguet range equation. (AAAE0903)

9.4 Stability: Effect of fuselage, wing and empennage design and placement on aircraft, performance and stability of airplanes, effects of power plant types (propeller and jet engines) and placement on aircraft performance and stability. (AAAE0904)

9.5 Flight vehicle design: Lift and drag estimation for aircraft design, estimation of weight ratios, wing loading and lift-to-drag ratio estimation, weight and balance, static and dynamic stabilities, and moment coupling, conceptual, preliminary and detail design process of an aircraft. (AAAE0905)

9.6 Flying qualities: Dutch roll, phugoid mode, short period, spiral mode, stall speed, sawtooth climb and sawtooth descent, Cooper–Harper rating scale, aircraft airworthiness requirements. (AAAE0906)

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)