Nepal Engineering Council Registration Examination

Earthquake Engineering Syllabus (AEqE)

Chapters 1-4 are fundamentals/principles of concepts in earthquake engineering; chapters 5-9 are related to application of earthquake engineering principles in practice; and the last (10th) chapter is related to earthquake disaster assessment, mitigation and management.

1. Fundamental of Earthquake Engineering (A*EqE* 01)

1.1 Historical perspective: Introduction, review of historical earthquake: Nepalese and global, their significant effects in human environment. (A*EqE* 0101)

1.2 Seismic Region of the world: Sources of earthquakes, world seismicity, earthquake statistics (*EqkE* 0102)

1.3 Geology of Nepal and Himalayas: Types of rocks, geological formation of Nepal Himalayas, faulting; strike slip, normal and reverse. (A*EqE* 0103)

1.4 Landslides and ground shaking hazard: Causes of landslides, earthquake shaking hazard. (*EqkE* 0104)

1.5 Tsunami and seiche: Tsunami vs. wind waves, geomorphology of tsunami generation, producing inundation maps. (A*EqE* 0105)

1.6 Fire following earthquakes: Introduction, selected fire following earthquakes, analysis. (A*EqE* 0106)

2. Soil Mechanics and Foundation Engineering (A*EqE* 02)

2.1 Soil properties and laboratory tests: tests for strength, permeability, compressibility, phase relationships; determination of index and engineering properties of soils; soil classification (descriptive, textural, ISI, MIT, USCS); boring log interpretation; sieve analysis and interpretation of results; determination of Atterberg limits of soils. (A*EqE* 0201)

2.2 Stresses on soil and seepage: effective stress (factors affecting effective stress, capillary rise, and quick sand conditions); seepage analysis [Seepage pressure, flow nets and their applications]; soil compressibility (including various indices) and compaction (definition, affecting factors).

(*EqkE* 0202)

2.3 Shear strength of soil and stability of slopes: Concept of shear strength, principal planes and principal stresses; Mohr-Coulomb theory of shear strength; calculation of normal and shear stresses at different planes; relation of principle stress at failure condition; types of shear tests; stability of slopes. (A*EqE* 0203)

2.4 Soil exploration, earth pressure and retaining structures: soil exploration (methods, planning, soil sampling and samplers, field tests, site investigation reports); earth pressure theories; stability analysis of retaining walls; techniques to increase stability of retaining walls. (A*EqE* 0204)

2.5 Fundamentals of foundation: Definition, Types (Shallow and Deep), functions, factor affecting, site investigation of foundation, concept of spread and mat foundation. (A*EqE* 0205)

2.6 Bearing capacity and foundation settlements: bearing capacity (types, effects of various factors); modes of foundation failure; Terzaghi's general bearing capacity theory; ultimate bearing capacity of cohesion-less and cohesive soils; consolidation (concept, types and tests); settlement (types, nature, effects and calculations) (A*EqE* 0206)

3. Geoscience Aspect **(A*EqE* 03)**

3.1 Seismology: Mechanism and class of earthquakes, estimation of ground motion, earthquake source model, time and frequency domain, measurement of earthquakes; magnitude and intensity, seismograph and accelerograms. (A*EqE* 0301)

3.2 Strong ground motion and simulations : Worldwide earthquake records, model parameters, statistical analysis, theoretical methods, engineering models and development of attenuation law, time and frequency domain analysis, Green function, simulation of strong motions. (A*EqE* 0302)

3.3 Wave propagation: Harmonic waves, elastic waves in long unbounded media: P and S wave, elastic waves in half space: Rayleigh waves, elastic wave in layered half space: Love wave, reflection and Refraction of body waves. (A*EqE* 0303)

3.4 Ground response analysis: Linear, equivalent linear and non-linear approach for one, two and three dimensional analysis, dynamic soil properties, bearing capacity for earthquakes. (A*EqE* 0304)

3.5 Seismic hazard analysis: Deterministic and probabilistic seismic hazard, magnitude frequency relationship, uncertainties related to source, size, temporal variation, probabilistic spectra, logic tree, deaggregation. (A*EqE* 0305)

3.6 Soil-structure interaction: Statement of problem, soil structure interaction analysis and response. (A*EqE* 0306)

4. Structural Mechanics **(A*EqE* 04)**

4.1 Shear forces and bending moments: Axial forces, shear forces, and bending moments; loads and load superposition; relationship and diagram Interpretation (AF, SF, BM). (A*EqE* 0401)

4.2 Stress and strain analysis: normal and shear stresses; principal stresses and principal planes; maximum shear stress and corresponding plane; stress-strain curves; torsion (A*EqE* 0402)

4.3 Theory of flexure and columns: co-planar and pure bending; elastic curve; angle of rotation; radius of curvature and flexural stiffness; deflection; bending stress; Euler's formula for long column. (A*EqE* 0403)

4.4 Determinate structures-1: Degree of determinacy, energy methods, virtual work method, deflection of beams and portal frame. (A*EqE* 0404)

4.5 Determinate structures-2: Influence lines for simple structures with point loads and UDL; analysis of three hinged arches. (A*EqE* 0405)

4.6 Indeterminate structures: Flexibility method, two-hinged parabolic arches, slope deflection method, moment distribution method, stiffness method, influence lines for continuous beams, plastic analysis. (A*EqE* 0406)

5. Design of Structures **(A*EqE* 05)**

5.1 Loads and load combinations: Dead load, imposed load, wind load, snow load, earthquake Load. (A*EqE* 0501)

5.2 Concrete technology: concrete technology (materials, properties, mix design, testing, quality control, and codes (IS and NS)). (A*EqE* 0502)

5.3 RCC structures-1: Working stress and limit state methods; design of beams and slabs; analysis of RC beams and slabs in bending, shear, deflection, bond and end anchorage; RCC; NS & IS codes. A(*EqE* 0503)

5.4 RCC structures-2: Design of columns and isolated/combined footings; pre-stressed concrete; NS & IS codes. (A*EqE* 0504)

5.5 Steel structures: Standard and built-up sections; design of bolted and welded connections; design of simple elements such as ties, struts, axially loaded columns, and column bases; NS and IS codes. (A*EqE* 0505)

5.6 Timber and masonry structures: Design principles of timber beams and columns; design of masonry structures, Nepal Building Code (NBC), failure modes of masonry structure, mud mortar, lime mortar and cement mortar and its properties. (A*EqE* 0506)

6. Structural Response (A*EqE* 06)

6.1 Theory of vibrations: Source of vibration, degree of freedom, single and multiple degree of freedom system, fundamental of dynamics, free and force vibration analyses, various kinds of damping, transverse vibrations, random vibrations, vibration of continuous system, earthquake response of system, response spectra (A*EqE* 0601)

6.2 Structural response: Classification of methods; central difference method; constant and linear acceleration methods; Newmarks methods; stability and accuracy issues (A*EqE* 0602)

6.3 Liquefaction Analysis: Definition of soil liquefaction, features of liquefaction induced damages, factor governing liquefaction, assessment of liquefaction potential, permanent displacement due to liquefaction, factor of safety against liquefaction. (A*EqE* 0603)

6.4 Dynamic properties of soil: Micro-tremor measurement, resonant column test, damping ratio, factors affecting shear modulus of soil. (A*EqE* 0604)

6.5 Seismic slope stability: Pseudo static approach, Newmark's sliding block methods. (A*EqE* 0605)

6.6 Design of retaining walls: Analyses for static and earthquake conditions, soil properties for seismic conditions, Pseudo-static method, retaining wall analyses for liquefied soil, retaining wall analyses for weakened soil, restrained retaining walls. (A*EqE* 0606)

7. Seismic Resistant Design of Aspects (AEqE07)

7.1 Design of steel structures: Historic development and performance of steel structures, structural systems, design of braced and unbraced frames. (A*EqE* 0601)

7.2 Design of reinforced concrete structures: Basic concepts, seismic behaviour, analytical models, seismic design, seismic retrofitting. (A*EqE* 0602)

7.3 Design and retrofitting of masonry structures: Behaviour of masonry, retrofitting principles, masonry design codes, retrofitting of historical masonry buildings. (A*EqE* 0603)

7.4 Base isolation: Philosophy of base isolation, basic requirements, design criteria, types of materials and properties (A*EqE* 0604)

7.5 Bridges: Earthquake damages of bridges, design philosophies, performance criteria, design approaches. (A*EqE* 0605)

7.6 Structural control: Concept of structural control, example of active and semi active controls. (A*EqE* 0606)

8. Lifeline Earthquake Risk Assessment and Management (A*EqE* 08)

8.1 Lifeline seismic risk: history of lifeline earthquake engineering, non-linearity of earthquake, direct and indirect economic loss, cost effective mitigation plans **(A***EqE* 0801)

8.2 Critical facilities: requirements of hospitals, school buildings, special administrative and security buildings, performance levels and design requirements. **(A***EqE* 0802)

8.3 Water, waste water and buried pipeline systems: pipe vulnerability and damage, component and system assessment, pipeline performance in the past, calculation of ground displacement in longitudinal and transverse directions mitigation methods. **(A***EqE* 0803)

8.4 Electric power & communication network systems: Historic response of electrical and communication systems, code provisions, earthquake preparedness and mitigation **(A*EqE* 0804)**

8.5 Dam and hydropower structures: Dam and earthquake, evaluation and design, upgrading of existing structures. **(A*EqE* 0805)**

8.6 Historic and heritage structures: Performance of historical buildings in past earthquakes, preservation, conservation and upgrading of historic structures. **(A*EqE* 0806)**

9. Earthquake Risk Management and Mitigation (A*EqE* 09)

9.1 Human impacts of earthquake: Introduction, casualties in historical earthquakes, standardized earthquake injury class scheme, casualty estimation methodology, mitigation and prevention, public health issues, shelter requirements. **(A*EqE* 0901)**

9.2 Hazardous materials: types of hazardous material, review of past earthquakes, storage and decomposition of harmful materials, safety, lesion learned, mitigation approaches. **(A*EqE* 0902)**

9.3 Loss estimation: Need of loss estimation, history of loss estimation, methods of estimation, damage, vulnerability, fragility, risk. **(A*EqE* 0903)**

9.4 Insurance and Risk Transfer: Insurance and insurance industry, earthquake risk assessment for government plan and policies, alter risk transfer. **(A*EqE* 0904)**

9.5 Emergency Planning: Planning for emergency, writing emergency plan, emergency operation centres, training, maintenance, developing emergency plan, Nepal government policy and plans. **(A*EqE* 0905)**

9.6 Earthquake mitigation plan: Overview of earthquake mitigation plan, phases of emergency plan: pre-program: assessment, development: implementation, maintaining program **(*EqkE* 0906)**

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)