

PAKISTAN ENGINEERING COUNCIL

Syllabus for Engineering Practice Examination (EPE)

Part-II/ (Breadth and Depth)-Geological Engineering

This is an open book breadth and depth examination, comprising 60 Multiple Choice Questions (MCQs) of one mark each (total 60 marks) with a duration of three hours. There shall be two sections of Part-II for each major discipline of EPE. Qualifying Marks for this part shall be **sixty percent**.

SECTION-A / BREADTH

Total Marks: 25

This section will generally confirm the latest (updated) B.E./equivalent qualification of Geological Engineering. The examination of this section shall comprise 25 MCQs (total 25 marks).

1. MATHEMATICS AND STATISTICS FOR ENGINEERS

7%

- i. Analytic geometry
- ii. Matrix operations
- iii. Differential equations
- iv. Differential calculus
- v. Measures of central tendencies and dispersions (mean, mode, standard deviation)
- vi. Estimation (point, confidence intervals) for a single mean
- vii. Regression analysis and curve fitting
- viii. Hypothesis testing.

Suggested Books:

- Thomas, George G., Jr. and Finney, Ross L., "Calculus & Analytical Geometry", Addison-Wesley, 8th Ed. ISBN: 0201529297
- Hogg & Craig, "Introduction to Mathematics & Statistics", Prentice Hall, 2004.
- Murray, Spiegel and Larry J- Stephens, "Probability and Statistics"
- S. C Gupta and V.K Kapoor, "Fundamentals of Mathematical statistics"
- Erwin Kreyszig, "Advanced Engineering Mathematics," Ninth Edition, 2005, International Edition, John Wiley & Sons, ISBN: 0471728977.

2. SURVEYING

7%

- i. Methods of surveying
- ii. Leveling, contouring, plane table surveying
- iii. Traversing
- iv. Basics of Geographic Information System (GIS) and Remote Sensing (RS)
- v. Photogrametry

- vi. Surveying Instruments: levels, theodolite, Electronic Distance Meter (EDM), total station, GPS (Global Positioning System)
- vii. Calculation of area and volume
- viii. Computations and setting out of curves
- ix. Tunnel surveying

Suggested Books:

- Davis, Raymond Earl, Francis Seeley Foote, and Joe Wallace Kelly. "Surveying theory and practice." (1966)
- Irvine W, "Surveying for Construction", McGraw Hill Inc., 4th edition 1997.
- Bannister, Raymond S, Baker R, Surveying, Pearson Education and Dorling Kindersley Publishing Inc. (1998).
- Kanetkar T.P., 2008, "Surveying & Leveling", Volume I & Volume II, Standard Publishers Distributors, India, 2008.
- Burrough P.A., and McDonnell R.A., "Principles of Geographical Information Systems", 352 pages, Oxford University Press, 1998.
- Geographic information system, available on: http://en.wikipedia.org/wiki/Geographic_information_system

3. Physical and Structural Geology

10%

- i. Origin of earth and its place in the universe.
- ii. Interior of earth and chemical composition of the earth crust, Mountain building and valley formation, drainage pattern and their types, weathering and erosion.
- iii. Theory of plate tectonics, earthquake and volcanism.
- iv. Classification and identification of rocks
- v. Megascopic identification of minerals.
- vi. Introduction to structural geology and its objectives, primary and secondary structures of igneous, metamorphic and sedimentary rocks.
- vii. Determination of dip, strike and thickness of beds.
- viii. Modes of deformation of rocks.
- ix. Parts, varieties and classification of folds, faults, joints and unconformities.

Suggested Books:

- Plummer, C.M., 2001. Physical Geology Earth Revealed, Mc-Graw Hill, 4th Ed.
- Tarbuck, E.J. and F.K. Lutgens and D.G. Tasa. 2014. Earth: An Introduction to Physical Geology, Pearson.
- Perkins, D. 2010 Mineralogy, Pearson, 3rd Ed.
- Fossen, H. 2010. Structural Geology, Cambridge University Press.
- Billings, M.P. 2016. Structural Geology, 3rd Ed, Pearson, India.

4. Fluid Mechanics and Hydrogeology

10%

- i. Properties of Fluids (Statics and Dynamics) and their measurement techniques (devices for the measurement of static pressure, velocity and discharge in pipes and open channels).
- ii. Flow in Pipes: minor and major losses in pipelines, empirical formulae for pipe flow, solutions of pipe flow problems and pipe networks
- iii. Flow in Open Channels: formulae for flow in open channels and most efficient hydraulic cross-section
- iv. Equations governing single fluid flow through saturated porous media under various geologic conditions.

- v. Principles of groundwater flows.
- vi. Aquifers and its types. Darcy's Law, Dupuit's equation, Equation of flow, Well hydraulics, Aquifer evaluation methods, Well design and construction.

Suggested Books:

- Finnemore, E.J & Franzini, J.B., 10th Edition. Fluid Mechanics with Engineering Application. McGraw Hill Book Co. Singapore.
- Jain, A.K. "Fluid Mechanics". Khanna Publishers, New Delhi, India, 1990.
- S.S. Rattan, "Fluid Machines" Khanna Publishers, New Delhi, India, 1994.
- Patra, K.C. 2008. Hydrology and Water Resources, Alpha Science International Ltd.
- Fetter, C.W. 2000. Applied Hydrogeology, Pearson.
- Todd, D.K. 2004. Groundwater Hydrology (3rd Edition), John Wiley and Sons.
- Subramanya. 1994 Engineering Hydrology (2nd Edition), Aata McGraw Hill Publishing Company, Ltd.
- Freeze, R.A. and J.A. Cherry. 1979. Ground Water, Prentice Hall.

5. Engineering Geology and Geotechnical Engineering

10%

- Engineering Properties of geological materials
- Soil and rock mass classification systems
- Soil and rock slope stability analysis.
- Earth and Rock Fill Dams: Definition of an earth dam, types of earth and rock fill dams, Components of an earth dam and their functions.
- Geotechnical Investigation: Soil and rock exploration, methods of ground exploration. Probing, test trenches and pits, auger boring, wash boring, rotary drilling, soil samplers, disturbed and undisturbed samples.
- Compaction: Fundamentals, moisture-density relationship, compaction standards, factors affecting compaction, field control and measurements of in-situ density. Field compaction equipment.
- Consolidation: Mechanics of consolidation, theory of one dimensional consolidation, odometer test and graphical representation of data

Suggested Books:

- Johnson, R.B. and J.V. Degraff. 1988. Principles of Engineering Geology, Wiley.
- Blyth, F.G.H. and M.H. de Freitas. 1984. A Geology for Engineers, CRC Press.
- Wyllie, Duncan C., and Chris Mah. 2004, Rock slope engineering. CRC Press.
- Hoek, E., 2000. Practical rock engineering.
- Das, B.M. 1998. "Principles of Geotechnical Engineering", 4th edition, PWS Publishing Company
- Coduto DP. Geotechnical engineering: principles and practices. 1999.
- Craig, R.F, "Soil Mechanics", Van Nostrand Reinhold (UK) Co. Ltd. 1983.
- Bowles, J.E "Foundation Analysis and Design", McGraw Hill Publishing Company, 1988.
- Aziz Akbar. 2011. Fundamentals of Soil Mechanics.
- Murphy, V.N.S. 2002. Geotechnical Engineering: Principles and Practice of Soil Mechanics and Foundation Engineering, CRC Press.

6. STRENGTH OF MATERIALS

8%

- i. Shear and moment diagrams
- ii. Stress types (normal, shear, bending, torsion)
- iii. Stress-strain caused by:
 - axial loads
 - bending loads
 - torsion
 - shear.
- iv. Deformations (e.g., axial, bending, torsion)
- v. Combined stresses
- vi. Columns
- vii. Indeterminate analysis
- viii. Plastic versus elastic deformation.

Suggested Books:

- G H Ryder, "Strength of Materials", 3rd Edition, Macmillan, 1969.
- Pytel, A. & F.L.Singer, "Strength of Materials", 4th Ed, Harper & row Publishers, 1987.
- Boreise, A.P. & O. M. Sidebottom, "Advanced Mechanics of Materials", 6th Ed, John Wiley & Sons, 2004.

7. Seismology and Geophysical Exploration

8%

- Introduction to earthquake hazards (e.g. liquefaction, landslides)
- Earthquake mechanics; wave propagation, instrumentation, surface waves.
- Earthquake risk assessment including the use of fault, earthquake history, strong Ground motion, attenuation, and principles of deterministic and probabilistic earthquake risk assessment.
- Introduction to geophysical exploration techniques: seismic, resistivity, gravity and magnetic surveys
- Seismic waves refraction and reflection
- Basic concept of resistivity for subsurface rocks/soils
- Resistivity Surveys Types

Suggested Books:

- Kramer, S.L. 2003. Geotechnical Earthquake Engineering, Pearson Education.
- Havskov, J. and G.Alguacil. 2004. Instrumentation in Earthquake Seismology Springer, Netherlands.
- Oliveira, C.S., A. Roca and X. Goula. 2006. Assessing and Managing Earthquake Risk Edited Springer, Netherlands.
- Edwin S. Robinson & Cahit Coruh. 1988. Basic Exploration Geophysics

SECTION-B / DEPTH

Total Marks: 40

This section shall be based on practical concepts framed to judge the practical experience and field based knowledge of Registered Engineers (REs). The examination of this section shall comprise 40 MCQs. Each candidate may attempt the only opted area of practice, among the followings.

1. GEOTECHNICS AND ROCK ENGINEERING

i. Subsurface Exploration

- Drilling and sampling procedures: methods and comparison of drilling methods, split spoon sampler, shelly, pitcher, denison and pistons, coring of rocks
- Field tests: In-situ Density Test, Standard Penetration Test (SPT), Cone Penetration Test
- Boring log interpretation.

ii. Compaction

- Proctor tests/ relative density tests
- Factors affecting compaction
- Field compaction equipment
- Site control procedure using sand cone/ core cutter methods.

iii. Classification of Soil

- Particle size distribution, uniformity coefficient, coefficient of curvature
- Atterberg limits
- Soil correlation and phase relations
- Unified classification system
- AASHTO classification system.

iv. Permeability

- Darcy's Law
- Hydraulic conductivity
- Flow nets, calculation of seepage, critical hydraulic gradient
- Capillarity in soils
- Well analysis (steady flow only).

v. Stresses in Soil Mass

- Principle of effective stress
- Stresses in soils
- Vertical stress increase due to various types of loadings.

vi. Consolidation

- Oedometer test, void ratio, log pressure plots, normally consolidated & over consolidated soils
- Settlement and consolidation
- Pre-compression of ground
- Sand drains.

vii. Shear Strength of Soil

- Mohr-Coulomb failure criteria
- Laboratory determination of shear strength parameters.

viii. Lateral Earth Pressure and Earth Retaining Structures

- Active, passive and at rest earth pressure
- Rankine and Coulomb earth pressure theories
- Gravity and cantilever walls
- Braced cuts.

ix. Slope Stability

- Finite and infinite slopes
- Pseudo static analysis

x. Shallow Foundations

- Tolerable, total and differential settlement
- Angular distortion
- Plate load tests.

xi. Deep Foundation

- Estimation of pile capacity (single pile and pile groups)
- Pile load tests
- Pile construction.

xii. Earthquake Engineering

- Seismic zoning of Pakistan
- Dynamic soil parameters
- Liquefaction.

xiii. Embankment Dams

- Types and components of earth dams
- Design considerations
- Stability and seepage analysis.

xiv. Soil Improvement Techniques, Dewatering Methods, Sheet piles

xv. Rock Engineering

- Basic concepts of stress and strain in rocks and their measurements
- Normal and effective stress
- Stresses orientation with depth
- Elastic properties of rocks
- Rock failure theories
- Fundamental Concepts of Rock Breaking, Classifications of underground structures and site investigation & Geological aspects regarding their design.
- Design and Construction of Underground Structures: Design of shape and size, Excavation methods including Drilling and Blasting and Mechanical Rock Fragmentation. Tunneling and Shaft Sinking in Problematic grounds. Ground treatment and water control methods. Support and Ventilation during construction of underground structures.
- Instrumentation in underground excavations: Objectives, Collection of design data and monitoring of excavations during and after construction.

Suggested Books:

- Das, B.M., “Principles of Geotechnical Engineering”, 4th edition, PWS Publishing Company, 1998.
- Craig, R.F, “Soil Mechanics”, Van Nostrand Reinhold (UK) Co. Ltd.1983.
- Bowles, J.E., “Foundation Analysis and Design”, McGraw Hill Publishing Company, 1988.
- [Karl Terzaghi](#), [Ralph Brazelton Peck](#), [Gholamreza Mesri](#) “Soil Mechanics in Engineering Practice” John Wiley and Sons, 1996.
- Goodman, R.E. 1989. Introduction to Rock Mechanics, John Wiley & Sons
- Obert, L. and W.I. Duvall. 1967. Rock Mechanics and the Design of Structure in Rock, Wiley.
- Tunnelling: Design, Stability and Construction by Whittaker B.N. and Frith R.C.

2. NATURAL ENERGY RESOURCES EXPLORATION

- i. Source and Reservoir rocks evaluation/characterization
 - Source and generation of Petroleum
 - Maturity of Petroleum
 - Types of Kerogen
 - Rock Pyrolysis
 - Migration, accumulation and trapping of Petroleum
 - Properties of Reservoir rock
 - Types of traps and their formation mechanism
- ii. Petroleum Geology of Pakistan
 - Basins of Pakistan and their natural resource potential
 - Generalized stratigraphy of different parts of Indus Basin
 - Source and Reservoir rocks of Pakistan
 - Major oil and gas fields of Pakistan
- iii. Seismic Reflection and Refraction
 - Theories of Seismic Reflection and Refraction
 - Refraction data acquisition, processing and interpretation
 - Reflection data processing and interpretation
 - Subsurface mapping using seismic data
- i. Electrical Survey
 - Resistivity data acquisition and types of survey’s configuration (e.g., Wenner, Schlumberger)
 - Resistivity data interpretation techniques
 - Resistivity Imaging/Tomography
 - GPR (ground penetrating radar) Survey
- ii. Gravity and Magnetic Survey
 - Gravity and Density
 - Gravimeters and their use
 - Gravity data interpretation
 - Magnetism in the subsurface
 - Magnetometer and their use
 - Magnetic data interpretation

- iii. Well Logging
 - Types of logs and their principles of data recording
 - Resistivity, Neutron, Density, Sonic, GR (gamma-ray) Caliper and SP (self-potential) logs
 - Well logs interpretation for reservoir rock characterization
 - Use of logs for well correlation
 - Estimation of engineering properties of rocks using logs

- iv. Drilling Engineering
 - Types and components of drilling rigs
 - Properties of drilling mud
 - Casing design for deep drilling
 - Types of drilling bits
 - Drill stem testing
 - Well Planning

Suggested Books:

- Edwin S. Robinson & Cahit Coruh. 1988. Basic Exploration Geophysics
- Asquith, G. B., D. Krygowski and C.R. Gibson. 2004. Basic Well Log Analysis (2nd Ed.).
- Halliburton A.D. 2001. Basic Petroleum Geology and Log Analysis.
- Rabia, H. (2002) Well Engineering & Construction. Entrac Consulting Limited, London.
- Gatlin, C. (2006) Petroleum Engineering: Drilling and Well Completions. Prentice-Hall, 2006.

3. Geoenvironmental Engineering

i. Geotechnics

- Soil formation, composition and fabric
- Index and geotechnical properties of soils
- Soil identification and classification
- Compaction characteristics of soils
- Consolidation characteristics of soils
- Shear and hydraulic characteristics of soils

ii. Geochemistry

- Types of organic and inorganic contaminants in soils
- Distribution of metals and NAPLs in soils
- Geochemical processes controlling contamination of metals and NAPLs in soils
- Chemical Analysis for metals and NAPLs
- Contaminant Transport Processes

iii. Environmental Geotechniques

- Solid Waste Management and Design: Sources, classification and characterization of solid waste. Use of earth and geosynthetic materials in waste containment liner and final cover systems. Landfill site selection, design and construction.
- Contaminated site characterization and remediation: Contaminated site assessment, site investigations to obtain geological hydrological and chemical data. ASTM procedure for risk assessment, fundamental processes of soil and groundwater remediation technologies.

Suggested Books

- Sharma, H. D., & Reddy, K. R. (2004). Geoenvironmental engineering: site remediation, waste containment, and emerging waste management technologies. John Wiley & Sons.
- Daniel, D. E. (Ed.). (2012). Geotechnical practice for waste disposal. Springer Science & Business Media.
- Qian, X., Koerner, R. M., & Gray, D. H. (2001). Geotechnical aspects of landfill construction and design. Prentice Hall.
