PAKISTAN ENGINEERING COUNCIL
Curriculum for Engineering Practice Examination (EPE)
Petro-Gas Engineering

Total Marks: 100.

MAIN OBJECTIVE:

The main objective of Engineering Practice Examination (EPE) is the assessment of competence, knowledge and skills of a Registered Engineer (RE), after having attained a minimum of five years of practical experience in relevant field of engineering from a recognized engineering organization, institution or allied service, and has earned requisite CPD (Continuing Professional Development) credit points.

PART-I (COMMON TO ALL DISCIPLINES)

This is common to all disciplines comprising of 30 questions of one mark each (total marks 30) with the duration of 2 hours, dealing with engineering related management, communication skills and ethics.

MANAGEMENT (ENGINEERING RELATED) 34%

i. Quality Issues: fundamental concepts, application and role
ii. Finance: cost analysis, financial discipline
iii. Procurement/Legal: bidding, contracts, arbitration, guarantees, liabilities
iv. Latest Trends: emerging technologies and their applications.

Suggested Books:

- PEC bidding/contract documents (www.pec.org.pk; www.picc.org.pk)
- FIDIC documents
- W.G. Sullivan, J.A. Bontandelli and E.M. Wicks, "Engineering Economy", 11th Ed., Prentice Hall Inc., 1999
- Franklin and John Stermole, "Economic Evaluation and Investment Decision Methods" (9th Edition)
- Project Management Institute , A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition, Published by Project Management Institute, weblink: A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition, 2008.

2. WRITTEN COMMUNICATION SKILLS 33%

i. English Language Communication Skills

- Paragraph and essay writing
- Academic and presentation skills

ii. Technical Report Writing Skills

- Project/ research proposals
- Monitoring and evaluation
- Progress and financial reporting

iii. Knowledge Management and Leadership Skills

Suggested Books:

- Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Writing. Intermediate.Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41
- Hargie, O. (ed.) Handbbook of Communications Skills, Routledge
- Ron White.Writing. Advanced. Oxford Supplementary Skills.Third Impression 1992, ISBN 0 19 435407 3
- Thomson,A.J and Martinet,A.V.Practical English Grammar, Exercises1, 3rd Ed., Oxford University Press, 1997. ISBN 0194313492.
- Ellen, K. 2002. Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top, Prima Lifestyles – 2005
- Oxford English Dictionary or equivalent, (Latest Edition)

3. ETHICAL AND SOCIAL ISSUES 33%

i. Code of ethics

ii. Professional obligation of engineers

iii. Role of opportunity and conflict

iv. Interpersonal relations, social stratification and culture

Suggested Books:

- PEC Code of Ethics (http://pec.org.pk/code_ethics.aspx)
- PEC Code of Conduct (http://pec.org.pk/code_conduct.aspx)
- Martin, M. W., Martin, M. and R. Schinzinger.Ethics in Engineering, McGraw-Hill, (Latest Edition)
- Whitbeck C.,Ethics in Engineering Practice and Research, Cambridge University Press, (Latest Edition)

- Finchan, R., & Rhodes, P. (2003), Principles of Organizational Behavior, 3rd Ed., Oxford.
- Project Management Institute , A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition, Published by Project Management Institute, weblink: A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition, 2008.

PART-II (BREADTH)

This part attempts to assess the breadth of Petro-Gas Engineering. The examination of this part would comprise 30 multiple choice questions (total 30 marks) for 2-hours duration.

1. PETROLEUM GEOLOGY & GEOPHYSICAL EXPLORATION

i. Theories of origin of Petroleum, Petroleum Composition.
ii. Geological structures and classification of Tectonic basins
iii. Sedimentary basins and sedimentary environments
iv. Subsurface Temperature, Pressure, subsurface Fluids and Fluid Flow.
v. Reservoir Rock characteristics.
vi. Reservoir Drive Mechanisms.
vii. Geophysical methods for Petroleum Exploration.

Suggested Books:

- Levorsen,A.I and Frederick A. F. Berry, 1967. Geology of Petroleum, American Association of Petroleum Geologists, 2 Edition 2001
- Peter K. Link., 1987. Basic Petroleum Geology Oil & Gas Consultants International 3rd Edition 2007.
- Edwin S. Robinson and Cahit Coruh, 1988, “Basic Exploration Geophysics”, Wiley.

2. DRILLING ENGINEERING

i. Drilling methods (rotary, wireline)
ii. Rotary drilling operations
iii. Rig components and their function
iv. Bit type, selection and evaluation
v. Casing design, landing and cementing practices
vi. Drilling fluids: function, types, composition and mud pump ratings
vii. Drilling hazards and their remedies.
viii. Pressure relations in the formations and bore hole.
ix. The hydrostatic heads of fluids including mud, and cement slurries.
x. Optimization of drilling parameters
xi. Drilling Types (Directional, horizontal, and off shore)

xii. Cement formulation & testing
xiii. Simulation of drilling operations & well control

Suggested Books:

- Neal J. Adams, 1985. Drilling Engineering: A Complete Well Planning Handbook Pennwell Corp
- S.D. Josh, 1991. Horizontal Well Technology Pennwell Corp,
- Erik B. Nelson, 1990. Well Cementing, Schlumberger Educational Services, Second Edition
- Hussain Rabia, 1986. Springer Oil well Drilling Engineering: Principles and Practice 1st edition.
- David Hawker & Karen Vogt Allan Robinson, "Well Site Procedures and Operations; Version 3.0, March 2001", (sections 11.8 and 11.9)

3. WELL LOGGING

i. Well logging and basic relationships
ii. Log Types and their interpretation
iii. Clean and Shaly Formations
iv. Cement Bond Logging (CBL) and Variable Density Log (VDL)
v. Well Logging Parameters (bulk Density , porosity, permeability, water saturation, reducible water saturation, resistivity index, Archie equation, bore-hole environment, logging environment etc)
vi. Modern well logging methods & interpretation (Open-hole, Cased hole)

Suggested Books:

- Zaki Bissouni, 1994. Theory, Measurement and Interpretation of Well Logs, Society of Petroleum Engineers,Text Book Series.
- Oberto Serra, 1987. Fundamentals of Well-Log Interpretation: The Interpretation of Logging Data, Elsevier Science.
- Malcolm,H.Rider& Martin,K, 2011. The Geological interpretation of Well Logs, Third Edition, Rider-French Consulting Limited.

4. PETROPHYSICS

i. Fundamental properties of fluid permeated rocks (porosity, Permeability, fluid saturations, compressibility, wettability and interfacial tension)
ii. Coring, core sampling and preservation
iii. Measurement and Interpretation of basic rock properties.

iv. Special core analysis (two and three Phase Relative Permeability, capillary pressure, acoustic, thermal conductivity and electrical properties
v. Relative permeability of oil-wet and water-wet rocks
vi. Relationship between porosity and permeability
vii. Leveret J-function for Capillary Pressure

Suggested Books:

- Djebbar Tiab and Erle C. Donaldson, Petrophysics, 2003. Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties, Gulf Professional Publishing; 3rd Edition 2011
- James W. Amyx, Daniel M. Bass, Robert L. Whiting, 1960. Petroleum Reservoir Engineering: Physical Properties, McGraw-Hill Book Company, Inc,

5. RESERVOIR FLUID PROPERTIES

i. Compositional analysis of Petroleum reservoir Fluids
ii. Basic concept of phase behavior; single, binary, and multi-component systems.
iii. Equations of State for real fluids and Correlations
iv. Determination of reservoir fluid properties by Field data
v. Properties of oil, gas, hydrates and water
vi. Analysis of fluid data for reservoir and production engineering calculations

Suggested Books:

- William,D and McCain,Jr.1990. The Properties Of Petroleum Fluids, Pennwell Pub;2nd Sub Edition,ISBN.0-87814-335-1.
- Tarek H. Ahmed, 1989. Hydrocrabon Phase Behaviour, Gulf Publication Co.,
- D.L. Katz, 1959, Handbook of Natural Gas Engineering, McGraw Hill.

6. RESERVOIR ENGINEERING-1

i. Volumetric determination of hydrocarbons in place and empirical reserve estimation
ii. Reservoir Drive mechanisms
iii. Darcy's law for multiphase fluid flow through porous media
iv. Average permeability calculations for beds in series and parallel for linear and radial reservoir geometry
v. Material Balance Equation (MBE)
vi. Basic differential equations for radial flow in porous media and its solutions
vii. Well inflow equations for stabilized flow conditions
viii. Pressure distribution and pressure gradient for linear, radial, compressible, slightly compressible, and incompressible steady state flow conditions

ix. Productivity, specific productivity, and injectivity indices

Suggested Books:

- L.P. Dake, 2005, Fundamental of Reservoir Engineering, Revised Edition,Elsevier Science
- Tarek Ahmed, 2010. Reservoir Engineering Handbook Gulf Professional Publishing 4th edition
- B. C. Craft, M. Hawkins, Ronald, E. Terry, 1991. Applied Petroleum Reservoir Engineering, Prentice Hall,2nd edition.

7. PRODUCTION ENGINEERING - I

i. Methods and types of well completions (reservoir and mechanical consideration)
ii. Perforation and its types
iii. Production packers, tubing strings, liners, subsurface completion and production control equipment
iv. Surface production facilities(wellhead, separators ,its types and capacity)
v. Completion and workover fluids
vi. Sand control procedures
vii. Production system analysis for single and multiphase fluid flow Performance Relationship
viii. Coiled tubing and its equipment operations
ix. Formation damage
x. Production Logging Tool (PLT)

Suggested Books:

- Michael J. Economides, Daniel A. Hill, Christine Ehlig-Economides, 1993. Petroleum Production Systems Prentice Hall; First Edition
- Thomas O. Allen and Alan P. Roberts 2006. Production Operations (Volume I & II) Oil & Gas Consultants International, Fifth edition.
- J.O. Robertson, G.V. Chilingarian, S. Kumar, 1989. Surface Operations in Petroleum Production, II Elsevier Science
- Michael Golan, 1987. Well Performance, Springer First Edition.

PART-III (DEPTH)

This part aims to assess the depth of Petro-Gas Engineering. The examination of this part would comprise 40 multiple choice questions for 3-hours duration. Each candidate can attempt the only opted area of practice, among the followings.

1. DRILLING ENGINEERING

i. Rotary drilling techniques- vertical drilling, directional drilling
ii. Directional drilling and deviation control, planning the directional well trajectory, kick off and trajectory change, deflection tools
iii. Horizontal drilling and deviation control
iv. Fishing operations and procedures, blowout, mud hydraulics prevention & control, drilling fluid properties & design
v. Formation damage, causes & prevention
vi. Drill Stem Testing (DST), procedure & consideration, test tool components, their arrangement & analysis of test data
vii. Planning, budgeting & cost control of drilling operation, tangible & intangible expenditure
viii. Bit selection & evaluation of wear penetrating cementing
ix. Arctic drilling, off shore drilling & development, rig, down hole problem, disposal of mud & solids, production system, environmental consideration
x. Formation pore pressure considerations
xi. Casing design and special design considerations
xii. Drilling economics, equipment cost and slim hole drilling
xiii. Measurement Pressure Drilling (MPD) & Under Balanced Drilling (UBD)
xiv. Blow out prevention and control

Suggested Books:

- David Watson Terry Brittenham Preston L. Moore, 2003. Advanced Well Control Society of Petroleum, 2003 edition.
- Hussain Rabia, 1986. Springer Oilwell Drilling Engineering: Principles and Practice 1st edition.
- William C Koger 1998.Drill string design handbook,MurchisonDrillingSchools, Inc.
- S.D. Josh, 1991. Horizontal Well Technology Pennwell Corp,
- Erik B. Nelson, 1990. Well Cementing, Elsevier.
- Neal J. Adams, 1985. Drilling Engineering: A Complete Well Planning Handbook Pennwell Corp
- Norton J. Lapeyrouse, 2002. Formulas and calculations for Drilling Production & Workover, Gulf Professional Publishing; 2nd edition.

2. RESERVOIR ENGINEERING

a. Reservoir Engineering- II.

i. Derivation of Material Balance Equation. M. B. Equation as an equation of a straight line.
ii. Kg/ko determination from field data and empirical correlations
iii. Performance Calculation for Depletion Drive reservoirs, Empirical Prediction technique for immiscible processes
iv. Method for Extrapolation of cut vs recovery curves, Performance of water drive reservoirs using Buckley-Leverett's Frontal Advance theory.
v. Water and Gas Fingering and Coning in homogeneous reservoirs, isotropic reservoirs, fractured reservoirs and Remedial Treatments for coning.
vi. Gas Condensate Reservoirs (as defined with reference to phase diagrams)
vii. Calculation of original gas and condensate in place for volumetric reservoirs,
viii. wet gas reservoirs, compositional analysis with and without the composition available.
ix. Well Testing and sampling.
x. Performance of volumetric retrograde gas condensate reservoir. Use of M.B for retrograde reservoir.

Suggested Books:

- M. Walsh, L.W. Lake 2003. Generalized Approach to Primary Hydrocarbon Recovery Elsevier Science 1st edition.
- Tarek Ahmed 2010. Reservoir Engineering Handbook, Gulf Professional Publishing,fourth edition.
- B. C. Craft,M. Hawkins, Ronald E. Terry, 1991 Applied Petroleum Reservoir Engineering, Prentice Hall, , 2nd Edition
- W. John Lee, Robert A. Wattenbarger, 1996. Gas Reservoir Engineering, Society of Petroleum Engineers.

b. Reservoir Simulation.

i. Basic theory and practice in reservoir simulation
ii. Formulation of equations governing single phase and multi-phase flow in porous media
iii. Finite difference methods and solution techniques.
iv. Techniques for developing black-oil compositional, thermal and dual porosity model
v. Practical Consideration in the use of simulators for predicting reservoir performance

vi. Well representation in simulators, Solution of Linear Difference equations applicable to the reservoir using Direct and Iterative methods

Suggested Books:

- Turgay Ertekin 2001. Basic Applied Reservoir Simulation,SPE Text book series.
- Donald W. Peaceman, 1977. Fundamental of Numerical Reservoir Simulation, Elsevier Science
- Calvin C. Mattax, Robert L. Dalton 1990. Reservoir Simulation Society of Petroleum ,SPE Monograph Series, Vol 13
- John R. Fanchi, 2001. Principle of Applied Reservoir Simulation, Gulf Professional Publishing, 2nd edition

c. Well Testing

i. Pressure draw down, build-up tests, Injection & fall off tests
ii. Average reservoir pressure, reservoir limits tests.
iii. Application of pseudo-pressure function, pressure square and pressure methods for analysis of gas well test
iv. Gas well deliverability test
v. Type curve matching
vi. Analysis of well tests affected by phase redistribution.

Suggested Books:

- John Lee, John B. Rollins & John P. Spivey, 2003. Pressure Transient Testing Society of Petroleum Engineers SPE Textbook Series, Vol. 9.
- Jr. Robert C. Earlougher 1977. Advances in Well Test Analysis Society of Petroleum Engineers of AIME (Henry L. Doherty Series, Monograph), Vol. 5.
- M.A. Sabet, 1991. Well Test Analysis, Gulf Professional Publishing, Vol. 8

d. Enhanced Oil Recovery (EOR)

i. Role of reservoir geology in the design and operation of EOR
ii. Displacement, Areal and vertical sweep efficiencies
iii. Dykstra-Parson's coefficient of permeability variations and other methods of characterizing reservoir heterogeneity
iv. Secondary recovery method (water and gas injection)
v. Thermal EOR: Cyclic steam and continuous steam injection methods
vi. Dry and Wet In-situ combustion
vii. Miscible EOR: CO_2 injection, Nitrogen injection, methane, flue gas injections
viii. Chemical EOR: polymer, surfactant/ foam, micelar/ polymer, alkaline

Suggested Books:

- G. Paul Willhite, 1986. Waterflooding, Society of Petroleum, Text book series.
- Don W. Green, and G, Paul Willhite, 1998. Enhanced Oil Recovery, Henry L. Doherty Memorial Fund of AIME, Society of Petroleum Engineers Volume 6.
- Marcel Latil, 1980. Enhanced Oil Recovery Gulf Publishing Co.

e. Natural Gas Engineering.

i. Natural gas properties
ii. Derivation of the basic flow equations for real gas, their solutions and applications for analyzing gas well testing, Analysis of hydraulically fractured gas well test
iii. Gas field Development
iv. Design of Gathering System
v. Field Treatment and processing of Natural Gas
vi. Flow and compression calculation
vii. Storage and transmission of Natural Gas
viii. Natural gas industry
ix. Sweetening and dehydration of crude gases
x. Distribution of gas in the city, gas stations,
xi. Gas flow measurements
xii. Corrosion control methods

Suggested Books:

- Harold Sill Bell, 1963. Petroleum Transportation Handbook, MCGRAW HILL.
- D.L. Katz, 1959. Handbook of Natural Gas Engineering, McGraw Hill.

3. PRODUCTION ENGINEERING

i. Well Diagnostics: Production Test, deliverability tests, Transient tests (PLT, PSP), Near well-bore damage characterization.
ii. Problem well analysis: Well Performance Prediction: Decline curve analysis, Material balance method, and reservoir simulators.
iii. Remedies.
iv. Well services and work over jobs: Squeeze jobs, re-perforation, well cleaning
v. Well stimulation
vi. Acidizing: Introduction, types of treatment, acid-fracturing design

vii. Hydraulic Fracturing: Introduction, inducing, productivity ratio, fracture area, fracturing fluid coefficients, fractures efficiency, fracturing hydraulics, fracture design and calculation.

viii. Artificial lift methods

ix. Gas Lift: Introduction, Application, Types and valve mechanisms. Accumulation chambers. Design of continuous-flow and intermittent gas lift system.

x. Surface oil production facilities scope of petroleum production engineering. Selection of separators, chokes, storage tanks

xi. Natural gas processing & Compression

Suggested Books:

- Michael J. Economides, Daniel A. Hill, Christine Ehlig-Economides, 1993. Petroleum Production Systems Prentice Hall; First Edition
- Thomas O. Allen and Alan P. Roberts 2006. Production Operations (Volume I & II) Oil & Gas Consultants International, Fifth edition.
- J.O. Robertson, G.V. Chillingarian, S. Kumar, 1989. Surface Operations in Petroleum Production, II Elsevier Science
- Michael Golan, 1987. Well Performance, Springer First Edition.
- Boyun Guo, William C. Lyons and Ali Ghalambor,Petroleum Production Engineering; A Computer Assisted Approach; Elsevier Science,ISBN: 0750682701.