

# PAKISTAN ENGINEERING COUNCIL

## Syllabus for Engineering Practice Examination (EPE)

### Petro-Gas Engineering

Total Marks: 60

#### PART-II

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 per cent*.

#### SECTION-A / BREADTH

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

#### 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. Hydrocarbon 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-II**

### **SECTION-B / DEPTH**

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 35 MCQs. Each candidate may 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, Murchison Drilling Schools, 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<sub>2</sub> injection, Nitrogen injection, methane, flue gas injections
- viii. Chemical EOR: polymer, surfactant/ foam, micellar/ 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.