

Petroleum Geomechanics

1.1 Course Number: PE422

1.2 Contact Hours: 3-0-0 Credits:9

1.3 Semester-offered: 4th Year-Odd

1.4 Prerequisite: Petroleum Geology / Formation Evaluation / Drilling Engineering / Reservoir Engineering

1.5 Syllabus Committee Member: Dr. Satish Kumar Sinha

2. **Objective:** This course is designed to give an overview of geomechanics used in oil and gas industry. Students will learn how geological, geophysical, petrophysical and engineering data are put together to a mechanical earth model. Such mechanical earth model can be used to address wellbore instability problems during drilling design.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Basic Mechanics	Concept of stress/strain Mechanical properties—Young's modulus, Poisson's ratio, bulk modulus, shear modulus, bulk compressibility Rock strength—UCS, tensile strength, and shear strength Computation of mechanical properties and strength parameters from logs Dynamic to static conversion of mechanical properties	10
2	Earth Stresses	In-situ stresses and plate tectonics Computing stress profile from logs Stress measurement and calibration—mini-frac/LOT/MDT tests Basic definitions of fracture gradient, closure pressure, and other terminologies used in lot/xlot How fractures are created—preferential direction, fracture growth (frac height and width)	7
3	Pore Pressure and Fracture Gradient	Normal, under, and overpressure reservoirs Measuring, predicting, and modeling of pore pressure Use of seismic in pore pressure estimation and modeling Pore pressure and the principle of effective stress	7
4	Rock Failure	Tensile versus shear failure Mohr-Coulomb criterion for rock failure Identifying rock failure from logs	5
5	Wellbore Stability	Factors causing wellbore instability Modelling and predicting Use of cavings and drill cuttings Planning proactively to avoid/reduce wellbore instabilities	6

		Rock mechanics in bit design	
6	Mechanical Earth Modelling (MEM)	Data requirements for a typical geomechanical analysis Process of building mechanical earth model Log data— use of full waveform sonic data Integrating log data, core data, and field stress measurements in MEM Calibration of geomechanical model	5
		Total	40

4. Readings

4.1 Textbook:

- Reservoir Geomechanics by Mark D. Zoback

4.2 Reference books:

1. Petroleum related rock mechanics by Erling Fjar, R.M. Holt, A.M. Raaen, R. Risnes and P. Horsrud
2. Petroleum Rock Mechanics: Drilling Operations and Well Design by Bernt Aadnoy, and Reza Looyeh
3. Journals from the American Association of Petroleum Geologists
4. Journals from the Society of Exploration Geophysicists
5. Journals from the Society of Petroleum Engineers

5 Outcome of the Course:

- Ability to estimate in-situ stresses and pore pressure in the subsurface
- Understanding the use of geological, geophysical, petrophysical and engineering data in building mechanical earth model