OE5120: GEOMECHANICS FOR OFFSHORE OIL AND GAS APPLICATIONS

Total Hours: 53 **Faculty: Dr. Rajesh R Nair**

COURSE STRUCTURE

I. Stress fields (*4 Hrs.*)

- Stress Patterns
- The Principal Stresses
- Stress Variations
- Calculation of Overburden Stress
- Stress Orientations and Relative Magnitudes
- Absolute Stress Magnitudes in Sedimentary Basins
- Depletion and Stress paths
- Predicting Porosity and Permeability Changes
- Stress Rotations Associated with Depletion
- Case Studies

II. Poromechanics (*4 Hrs.*)

- Elasticity
- Elastic Moduli and Seismic Wave Velocity
- Elastic Anisotropy
- Poroelasticity and Effective Stress
- Poroelasticity and Dispersion
- Thermoporoelasticity

III. Rock Strength **(*4 Hrs.*)**

- Failure Criteria
- Strength and Pore Pressure
- Rock Strength from Geophysical Logs
- Rock Strength Anisotropy
- Hydraulic Fracture
- Estimating Rock Strength from Geophysical Logs

---------- **FIRST QUIZ – 10.09.2015 (Thursday)** ----------

IV. Faults and Fractures **(*6 Hrs.*)**

- Opening Mode Fractures and Shear Faults
- Observations of Fractures and Faults at Depth
- Fracture Mechanics in Metals & Non-metals
- Computational Fracture Mechanics
- Drilling-Induced Tensile fractures
- Basic Concepts of Critically Stressed Faults
- Observations and Modeling of Fault Damage Zones
- Sealing and Leaking Faults
- Dynamic Hydrocarbon Migration
- Fractured Reservoirs and Permeability Anisotropy
- Case Studies

V. Wellbore Stability **(*4 Hrs.*)**

- Compressional Wellbore Failure

- Wellbore Breakouts
- Basic Principles of Deviated Wellbore
- Tensile Fractures and Borehole Breakouts in Deviated Wells
- Estimating Stress from Failure of Deviated Wells
- A Criterion for Wellbore Stability
- Case Studies
- Wellbore Ballooning

---------- **SECOND QUIZ – 17.10.2015 (Saturday)** ----------

VI. Geomechanics of Shale Gas and Tight Oil Production **(6 *Hrs.*)**

- Opportunities of Shale Gas Production
- Horizontal Drilling and Multi-stage Hydraulic Fracturing
- Physical Properties of Shale Gas Reservoir Rocks
- Microseismic Events and Reservoir Stimulation
- Microseismic Events and Production
- Stimulation of Fracture Networks
- Shale and Permeability Sorption
- Long Period Long Duration Seismic Events
- Geomechanical Constraints on Fracture Networks
- Horizontal Drilling and Multi-Stage Hydraulic Fracturing
- Environmental Protection

VII. Induced and Triggered Seismicity **(*1 Hr.*)**

- Injection-Induced Earthquakes

- Triggered Slip on Basement Faults
- Predicting Slip on Potentially Active Faults
- Case Studies

VIII. Problem Sets **(*24 Hrs.*)**

----------**END SEMESTER EXAMINATION – 27.11.2015 (Friday)** ----------

Grading:

1. First Quiz 25%
2. Second Quiz 25%
3. Problem Sets 10%
4. End-Semester Examination 40%

Recommended References

Berkhout, A. J. (1987). *Applied seismic wave theory*.

Fjar, E., Holt, R. M., Raaen, A. M., Risnes, R., & Horsrud, P. (2008). *Petroleum related rock mechanics* (Vol. 53). Elsevier.

Meyers, M. A., & Chawla, K. K. (2009). *Mechanical behavior of materials* (Vol. 2, pp. 420-425). Cambridge: Cambridge University Press.

Zoback, Mark D. (2010). *Reservoir Geomechanics*. Cambridge University Press.

Points to keep in mind:

Group study

- Interaction with peers and instructors.

- Discussions with TA.

Ask questions

- Read ahead.
- Feel free to ask questions.
- Make comments or just express your opinions.

Think

- Ponder over all kinds of problems.
- Strive for 100% on the assignments utilizing all the resources and opportunities available to you.

Expanding your mind

- Expand your mind.
- Be persistent
- Don’t give up, hang in there.
- If you have questions, ask the instructor or the TA.

Make it a game to master new skills and knowledge. Be courageous in facing new challenges.

“Great dreams of great dreamers are always transcended.” – A. P. J Abdul Kalam

Overview

The state of equilibrium of a rock formation is disturbed by drilling, production, or injection resulting in changes to the mechanical state of the rock. Such changes can seriously impact drilling operations, completions infrastructure, and production performance, all of which can result in unexpected cost and time overruns. Geomechanics related issues are thought to cause almost half of drilling-related NPT in HPHT, deep water, and other challenging environments.

Without a strategy for avoiding or minimizing potential geomechanical problems, your project may cost millions more than budgeted. Today, most operators consider geomechanics analysis and planning a necessary strategic component of exploration and field development activities. Identifying potential issues, planning for, and managing those saves time and improves safety at the wellsite.

Geomechanical factors affect every part of the life cycle of an oil and gas reservoir. It is important to assess and manage these, from predicting drilling risks in the first well to maximizing recovery from mature assets.

Geomechanics Management – Drilling

The first consideration of geomechanics is often for drilling design. Wellbore stability and pore pressure analysis will establish the mud weight boundaries available to safely drill a well without costly delays or incidents.

Pore Pressure Prediction| Well Placement & Trajectory | Wellbore Stability | Salt Creep | Drilling Geomechanics Services

Geomechanics Completions

Once in the reservoir, geomechanics is an important component of the completion design, whether to avoid sanding, or to develop a stimulation strategy to enhance production.

Sand Production Management | Perforation Optimization | Stimulation Geomechanics

Geomechanics for the Reservoir

Changes in the levels of subsurface stress during the life of an oil or gas field can induce formation compaction and subsidence, changes in permeability and fault reactivation.

Compaction/Subsidence | Cap-rock Integrity | Naturally Fractured Reservoirs | Production Field-wide | Dynamic Reservoir Geomechanics | Fault Seal Analysis | Unconventional Reservoirs