PE6040 : Seismic data acquisition, Processing and Interpretation

Total Hours: 50 **Faculty: Dr. Rajesh R Nair**

COURSE STRUCTURE

I.THEORY OF SEISMIC WAVE (5 ***Hrs.***)

- Introduction to elasticity theory
- wave equation,
- Plane and spherical wave solutions,
- Seismic Waves
- Marine 3-D data acquisition
- Marine shear wave acquisition
- 3-D land acquisition
- Types of seismic survey

II. GEOMETRY OF SEISMIC WAVES (5***Hrs.***)

- Normal-moveout calculations
- Dip, cross-dip, and angle of approach
- Depth and dip calculations using velocity functions
- Weathering corrections and dip/depth calculations
- Two-layer refraction problem

III. SEISMIC REFLECTION METHOD (5 ***Hrs.***)

- Field techniques
- Seismic data processing – Fourier transforms
- convolution, and correlation, deconvolution and frequency filtering
- automatic statics determination
- velocity analysis
- preservation of amplitude information
- migration methods
- DMO and prestack migration

- Depth migration

----------**FIRST QUIZ** ----------

IV. SEISMIC Seismic velocity **(3 Hrs.)**

- Maximum porosity versus depth
- Relation between lithology and seismic velocities
- Porosities, velocities, and densities of rocks
- Velocities in limestone and sandstone
- Dependence of velocity-depth curves on geology
- Determining lithology from well-velocity surveys
- Reflectivity versus water saturation
- Effect of overpressure
- Effects of weathered layer (LVL) and permafrost
- Stacking velocity versus rms and average velocities
- Well-velocity survey
- Effect of timing errors on stacking velocity, depth, and dip
- Estimating lithology from stacking velocity
- Velocity versus depth from sonobuoy data
- Influence of direction on velocity analyses

V. Reflection field methods **(4 Hrs.)**

- Reflection-point smear for dipping reflectors
- Attenuation of air waves
- Maximum array length for given apparent velocity
- Noise tests
- Selecting optimum field methods
- Optimizing field layouts
- Selecting survey parameters
- Interpreting uphole surveys
- Weathering and elevation (near-surface) corrections
- Determining static corrections from first breaks

- Determining reflector location

----------SECOND QUIZ ----------

VI. Seismic Data processing **(3 Hrs.)**

- Fourier series
- Fourier transforms of the unit impulse and boxcar
- Alias filters
- Calculating crosscorrelation and autocorrelation
- Convolution and correlation calculations
- Deconvolution methods
- Inverse filter to remove ghosting; Recursive filtering
- Ghosting as a notch filter
- Autocorrelation
- Apparent-velocity (f -k) filtering
- Kirchhoff migration
- Effects of normal-moveout (NMO) removal

VII. SPECIALIZED TECHNIQUES (***3 Hrs.***)

- Exploration with Swaves
- Channel waves
- Vertical seismic profiling
- Seismic tomography
- Borehole studies
- Passive methods
- Geostatistical methods

VIII. Problem Sets and Field Training Exercises (***18 Hrs.***)

–----------END-SEMESTER EXAMINATION –----------

Grading:

1. FirstQuiz 10%

2. Second Quiz 10%
3. Problem Sets 15%
4. Field Training Exercises 25%
5. End-Semester Examination 40%

Recommended references:

- Sheriff R.E. and Geldart L.P., Exploration Seismology, 2nd edition, Cambridge University Press, Cambridge, 1995.
- Payton C.E., Seismic Stratigraphy – Applications to Hydrocarbon Exploration, Memoir of the American Association of Petroleum Geologists 26, Tulsa, Oklahoma, 1977.
- Yilmaz O., Seismic Data Analysis: Processing Inversion and Interpretation of Seismic Data (Vols. 1&2), Society of Exploration Geophysicists, Tulsa, Oklahoma, 2001.
- Hardage B.A., Seismic Stratigraphy, Elsevier, Amsterdam, 1987.
- Bullen K.E. and Bolt B.A., An Introduction to the Theory of Seismology, Cambridge University Press, 1985.
- Bath M., Introduction to Seismology, Birkhauser Verlag, Basel, 1973.
- Coffeen J.A., Interpreting Seismic Data, Penn Well, 1984.

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.

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

‘’Excellence is a continuous process and not an accident." - A. P. J. Abdul Kalam

Overview

- ✓ Interdisciplinary physical science concerned with the nature of the earth and its environment and as such seeks to apply the knowledge and techniques of physics, mathematics and chemistry to understand the structure and dynamic behavior of the earth and its environment.
- ✓ Science which deals with investigating the Earth, using the methods and techniques of Physics.

The physical properties of earth materials (rocks, air, and water masses) such as density, elasticity, magnetization, and electrical conductivity all allow inference about those materials to be made from measurements of the corresponding physical fields - gravity, seismic waves, magnetic fields, and various kinds of electrical fields. Because Geophysics incorporates the sciences of Physics, Mathematics, Geology (and therefore Chemistry) it is a truly multidisciplinary physical science.

Exploration Geophysics

Physical principles are applied to the search for, and evaluation of, resources such as oil, gas, minerals, water and building stone.