UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCES AND ENGINEERING

INTRODUCTION TO APPLIED GEOPHYSICS

MS in Petroleum Geoengineering

2023/24 Semester 1

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth and Environmental Sciences and Engineering
Institute of Exploration Geosciences

Course datasheet

Course Title: Introduction to applied geophysics	**Credits: 3**

Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec.2, sem. 1**

Neptun code: MFGFT7100052

Type of Assessment (exam. / pr. mark. / other):**exam**

Condition for obtaining the signature: attendance at minimum 60 % of the lessons in the semester. The examination grade is determined on the basis of examination performance. The form of examination is typically written, but oral questions must be answered when the result of test is ambiguous.

Grading limits:
0 – 49 % → 1 (fail), 50 – 64 % → 2 (pass), 65 – 79 % → 3 (satisfactory), 80 – 89 % → 4 (good), 90 – 100 % → 5 (excellent)

Position in Curriculum (which semester): **first**

Pre-requisites *(if any)*:

Course Description:

Acquired store of learning:
Study goals: Introduction to applied geophysical methods and their basic interpretation with special emphasis on geophysical exploration and well logging used in hydrocarbon exploration.
Course content: Introduction, general overview and classification of geophysical techniques used in oil and gas industry. The geophysical methods in the different phases of hydrocarbon exploration. Role of geophysical information in oil and gas reservoir lifecycle. Exploration geophysical methods with low resolution (gravity, magnetic, radiometry, geothermal surveys). Electromagnetic methods in oil & gas industry. Seismic exploration methods (bases of elastic wave propagation; vertical and horizontal resolution; corrections, migration, time-depth conversion; VSP; bright spot and AVO classes). Basic principles and practice of borehole geophysics. Important well logs of open and cased hole applied in petroleum industry. Technical, geological, geophysical, production information gained by well logging.
Education method: lectures with projected PowerPoint presentation, examples for practice, assigning tasks.

Competencies to evolve:

- Knowledge of geological and geophysical surveying methods suitable to find oil and natural gas resources.
- Ability to understand the laws and connections and to apply the acquired knowledge.
- Ability to explore hydrocarbon-bearing geological structures in a workmanlike manner and to plan the exploitation process.
- Ability to plan the surface and well-logging geophysical investigations, to make and control measurements, to process and evaluate the measurement data, to make geological and geophysical interpretation, to review these operations.
- Intuition, systematism, learning skill.
- Demand for continual renewal of technical skills.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- updated slide decks of the lectures converted in pdf format: http://geofizika.uni-miskolc.hu/education.html
- Gadallah M., Fisher R., 2009: Exploration Geophysics, Spinger-Verlag.
- Kearey P., Brooks M., Hill I., 2002: An Introduction to Geophysical Exploration, Blackwell Publishing.

- Bacon M., Simm R., Redshaw T., 2007: 3-D Seismic Interpretation, Cambridge University Press.
- Serra O., 2007: Well Logging and Reservoir Evaluation, Technip.
- Telford W. M., Geldart L. P., Sheriff R. E., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press.
- D. V. Ellis, J. M. Singer, 2007: Well logging for earth scientists. Springer, Dordrecht, The Netherlands, ISBN 978-1-4020-3738-2 (HB).
- O. Serra, L. Serra, 2004: Data Acquisition and Applications, Editions Serralog, France, ISBN: 978295156125
- M. Rider, 1986. The geological interpretation of well logs. 2nd edition. Rider – French Consulting Ltd., Sutherland, Scotland, ISBN: 0-9541906-0-2.

Responsible Instructor(*name, position, scientific degree):*

Péter Vass Dr., associate professor, **László Gombár Dr.,** honorary associate professor

Syllabus of the semester

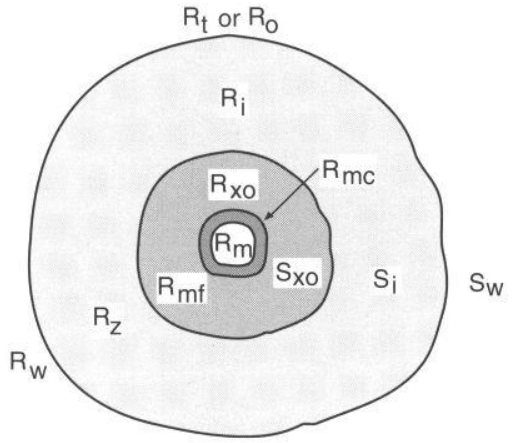
Date	Lecture
12/09/2023	The most important rock physical parameters. Overview of the different geophysical methods used in the successive phases of HC exploration.
19/09/2023	Gravitational method
26/09/2023	Magnetic method
03/10/2023	The group of geoelectric and electromagnetic methods. DC current methods, frequency sounding, VLF (very low frequency) method. MT, CSEM, transient methods, GPR.
10/10/2023	Basic principles and practice of borehole geophysics. The main features of wireline logging and logging while drilling. The main features of open-hole, cased-hole and production well logging.
17/10/2023	Physical bases and instrumentation of wireline logging operations.
24/10/2023	Classification and short overview of important open and cased hole well logging methods applied in the petroleum industry.
31/10/2023	No education
07/11/2023	Application of well logging in geothermal surveys. Estimation of static bottom hole temperature.
14/11/2023	Physical principles of radioactive and nuclear measurements.
21/11/2023	Seismic exploration methods (bases of elastic wave propagation, reflection and refraction methods).
28/11/2023	Seismic exploration methods (recording systems, vertical and horizontal resolution, corrections).
05/12/2023	Seismic exploration methods (data processing, stacking and migrated sections)
12/12/2023	Vertical Seismic Profiling (VSP, synthetic seismograms, time-depth conversion)

Date	Seminar
12/09/2023	The most important rock physical parameters. Overview of the different geophysical methods used in the successive phases of HC exploration.
19/09/2023	Gravitational method
26/09/2023	Magnetic method
03/10/2023	Applications of geoelectric and electromagnetic methods in HC exploration.
10/10/2023	Basic principles and practice of borehole geophysics. The main features of wireline logging and logging while drilling. The main features of open-hole, cased-hole and production well logging.
17/10/2023	Physical bases and instrumentation of wireline logging operations.
24/10/2023	Log Quality Control (LQC). Important aspects of working out logging programs.
31/10/2023	No education
07/11/2023	Application of well logging in geothermal surveys. Estimation of static bottom hole temperature.
14/11/2023	Physical principles of radioactive and nuclear measurements.
21/11/2023	Seismic exploration methods (bases of elastic wave propagation, reflection and refraction methods).
28/11/2023	Seismic exploration methods (recording systems, vertical and horizontal resolution, corrections).
05/12/2023	Seismic exploration methods (data processing, stacking and migrated sections)
12/12/2023	Vertical Seismic Profiling (VSP, synthetic seismograms, time-depth conversion)

Example test paper

date

1. Write down the meanings of the notations below. (max. points 8 x 1)



R_m : ……. R_{mc} : ……

R_{mf} : ……. R_{xo} : ……

S_{xo} : ……. S_w : …….

R_t : ……... R_o : …….

2. Read the sentences below. Some of them are false. Find and correct them. Write the corrected form below the sentence. (max. points 6 x 2)

Effective porosity includes both the interconnected and the isolated porosities.

……

……..……

Compressional waves propagate in both solids and fluids.

……

……..……

The saturation of a fluid in a porous rock gives the ratio of the volume filled with the fluid to the total bulk volume of the rock.

……

……

Generally, the lower the formation porosity, the deeper the invasion.

……

……..……

Permeability is a measure of the ability of a porous medium to let a fluid through itself.

……

……..……
The velocity of compressional wave is significantly lower in a highly porous rock filled with water than in a tight consolidated rock (without porosity).
……
……

3. Complete the sentences with the right words. (max. points: 21)

It is important to note that not the particles travel through the medium during the propagation of an ……..., but the change in the stress and strain fields. (1 point)

The measured bulk density (ρ_b) depends on the ……..., the ……., and the ……. in the pores. (3 points)

There are two types of body waves: (2 points)
……..
……..

During ……., an incident neutron has not enough energy to excite a nucleus, but it can increase the kinetic energy of the nucleus by their collision. (1 point)

Because the nucleus of ……. is a single proton, whose mass is very similar to that of a neutron, …… has the greatest capability of neutron slowing down. (2 points)

There are three conventional porosity measurements in well logging: (3 points)
……
……
……

From a petrophysical point of view, the model of a reservoir rock has three main components: (3 points)
……
……
……

The main components of a wireline logging system: (3 points)
……,
……,
……..

The natural radioactivity of rocks is caused by the following elements: (3 points)
……
……
……

4. How the clay or shale content influences the *effective porosity*, the *residual water saturation*, the *permeability* and the (*electric) resistivity* of a reservoir rock? (4 points)

Maximum points: 45 Acquired points: ……

Range	Mark
0 ≤ and < 22	1
22 ≤ and < 29	2
29 ≤ and < 36	3
36 ≤ and < 41	4
41 ≤ and ≤ 45	5

Mark: ……

Solution of the test

1.

resistivity of mud	resistivity of mudcake
resistivity of mud filtrate	resistivity of flushed zone
mud filtrate saturation of flushed zone	formation water saturation
true resistivity of hydrocarbon-bearing bed	true resistivity of water-bearing bed

2.

False. Corrected statement.
Total porosity includes both the interconnected and the isolated porosities.

True.

False. Corrected statement.
The saturation of a fluid in a porous rock gives the ratio of the volume filled with the fluid to the total pore volume of the rock.

True.

True.

True.

3.

elastic wave

density of rock matrix, porosity, density of fluid,

compressional (or P-) wave, shear (or S-) wave

elastic scattering

hydrogen, hydrogen

formation density logging, neutron porosity logging, acoustic travel-time (or sonic) logging

solid rock matrix, fluid filled pore space, shale or clay

potassium, uranium, thorium

4.
The increase of clay or shale content in a rock formation decreases the effective porosity, permeability and electric resistivity of the rock, but increases the residual water saturation.