INTRODUCTION TO APPLIED GEOPHYSICS

Petroleum Geoengineering MSc

2020/21 Semester 1

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth Science and Engineering
Institute of Geophysics and Geoinformatics

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:
T1, T4, T5, T11, T12, K4, K5, K6, K7, K9, K10, A1

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):* **László Gombár Dr.,** honorary associate professor (33.3%)**, Péter Vass Dr.,** associate professor (33.3%), **Endre Nádasi**, assistant lecturer (33.3%)**,**

Syllabus of the semester

Week	Lecture
08/09/2020	Seismic exploration methods (bases of elastic wave propagation, reflection and refraction methods).
15/09/2020	Seismic exploration methods (recording systems, vertical and horizontal resolution, corrections).
22/10/2020	Seismic exploration methods (data processing, stacking and migrated sections)
29/09/2020	Vertical Seismic Profiling (VSP, synthetic seismograms, time-depth conversion)
06/10/2020	The most important rock physical parameters. Overview about the order and resolution of different geophysical methods in the course of the different phases of HC exploration.
13/10/2020	The instrumentation of gravity, magnetic, radiometric, geothermal, EM (MT, CSAMT, marine EM) methods, the measured geophysical parameters.
20/10/2020	Day of professionals' lectures (no education)
27/10/2020	The physical and other parameters influencing the measured quantities by the methods mentioned in the previous week.
03/11/2020	Corrections and processing of the data gained by the methods presented earlier. Interpretation of these methods.
10/11/2020	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.
14/11/2020	Physical bases and instrumentation of wireline logging operations.
24/11/2020	Important well logs of open and cased hole applied in petroleum industry.
01/12/2020	Technical, geological, geophysical, production information gained by well logging.

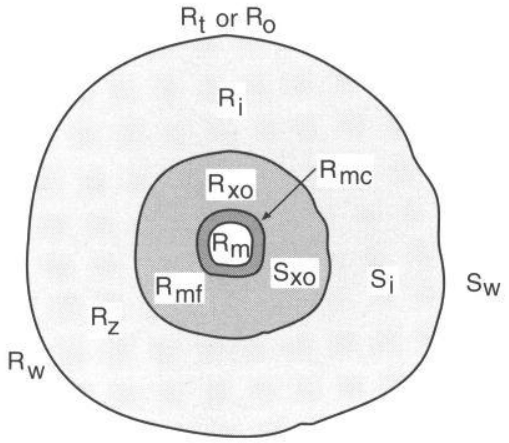
08/12/2020	Log Quality Control (LQC). Logging programs

Week	Seminar
08/09/2020	Seismic exploration methods (bases of elastic wave propagation, reflection and refraction methods).
15/09/2020	Seismic exploration methods (recording systems, vertical and horizontal resolution, corrections).
22/10/2020	Seismic exploration methods (data processing, stacking and migrated sections)
29/09/2020	Vertical Seismic Profiling (VSP, synthetic seismograms, time-depth conversion)
06/10/2020	Radiometric dating calculation.
13/10/2020	Calculation and comparison of heat flux gained by conduction and convection.
20/10/2020	Day of professionals' lectures (no education)
27/10/2020	Corrections and processing of the data gained by the methods presented earlier. Interpretation of these methods, case histories.
03/11/2020	Test in gravity, magnetic, radiometric, geothermal, EM methods
10/11/2020	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.
14/11/2020	Physical bases and instrumentation of wireline logging operations.
24/11/2020	Important well logs of open and cased hole applied in petroleum industry.
01/12/2020	Technical, geological, geophysical, production information gained by well logging.
08/12/2020	Log Quality Control (LQC). Logging programs

Example test paper in well logging

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

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.