INTRODUCTION TO APPLIED GEOPHYSICS

Petroleum Geoengineering MSc

2018/19 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**

In the course of the practical lessons there are individual problem solutions and assignments. Field practice is also planned. Assigments have 30%, final exam has 70 % in the grade weithing.

Grading limits:
> 80%: excellent,
70-80%: good,
60-69%: satisfactory,
50-59%: pass,
< 50%: fail.

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 geophyisal exploration and well logging used in HC 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 HC 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.
Special laboratory and field exercises contribute to the efficiency of this course.
Eduction method: Presentations using PC and projector, laboratory and field exercises, assignments about the exercises.
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**:

- 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., ass. prof., Gábor Pethő Dr., private prof., Péter Vass Dr., ass. professor

Syllabus of the semester

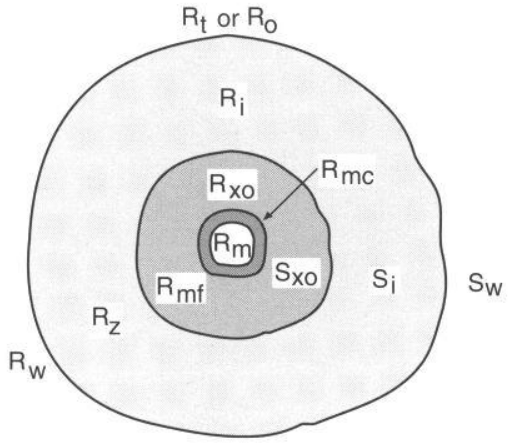
Week	Lecture
11/09/2018	The most important rock physical parameters. Overview about the order and resolution of different geophysical methods in the course of the different phases of HC exploration.
18/09/2018	The instrumentation of gravity, magnetic, radiometric, geothermal, EM (MT, CSAMT, marine EM) methods, the measured geophysical parameters.
25/10/2018	The physical and other parameters influencing the measured quantities by the methods mentioned in the 2nd week.
02/10/2018	Corrections and processing of the data gained by the methods presented in the 2nd week. Interpretation of these methods.
09/10/2018	Seismic exploration methods (bases of elastic wave propagation).
16/10/2018	Seismic exploration methods (vertical and horizontal resolution, corrections).
30/10/2018	Seismic exploration methods (migration and time-depth conversion).
06/11/2018	Vertical Seismic Profiling (VSP)
13/11/2018	Bright spots and AVO classes.
20/11/2018	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.
27/11/2018	Physical bases and instrumentation of wireline logging operations.
04/12/2018	Important well logs of open and cased hole applied in petroleum industry.
11/12/2018	Technical, geological, geophysical, production information gained by well logging.

Week	Seminar
11/09/2018	Radiometric dating calculation.
18/09/2018	Calculation and comparison of heat flux gained by conduction and convection.
25/10/2018	Corrections and processing of the data gained by the methods presented in the 2nd week's lecture. Interpretation of these methods, case histories.
02/10/2018	Test in gravity, magnetic, radiometric, geothermal, EM methods
09/10/2018	Seismic exploration methods (bases of elastic wave propagation).
16/10/2018	Seismic exploration methods (vertical and horizontal resolution, corrections).
30/10/2018	Seismic exploration methods (migration and time-depth conversion).
06/11/2018	Vertical Seismic Profiling (VSP)
13/11/2018	Bright spots and AVO classes.
20/11/2018	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.
27/11/2018	Physical bases and instrumentation of wireline logging operations.
04/12/2018	Important well logs of open and cased hole applied in petroleum industry.
11/12/2018	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
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.