INTRODUCTION TO PETROPHYSICS

MSc in Petroleum Geoengineering

First semester 2018/2019

COURSE COMMUNICATION DOCUMENT

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

Course datasheet

Course Title: Introduction to petrophysics	**Credits: 3**
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec. 2, sem. 1**	
Neptun code: MFGFT710006	
Type of Assessment (exam. / pr. mark. / other): **exam (oral)** Attendance at lectures is regulated by the university code of education and examination. Writing two tests during the term and making one powerpoint presentation on an assigned topic (condition of signature). **Grading limits:** >86 %: excellent, 71-85 %: good, 51-70 %: medium, 41-50 %: satisfactory, <40 %: unsatisfactory.	
Position in Curriculum (which semester): **first**	
Pre-requisites *(if any)*:	
Course Description:	
Acquired store of learning: Study goals: The topic provides rock physical basis for petroleum applications and the theory and practice of wireline logging measurements. Course content: Petrophysical properties of rock formations. Electromagnetic, seismic, acoustic wave propagation in rocks. Rock mechanical studies, velocity versus pressure relationships. Rock physical models (Hooke, Kelvin-Voigt, combined models). The borehole and its environment. Petrophysical modeling of hydrocarbon formations. Physical principles of well-logging methods. Open-hole wireline logging methods: lithological (natural gamma-ray intensity, spectral gamma-ray intensity, spontaneous potential), porosity (neutron-neutron, gamma-gamma, acoustic) and saturation-sensitive (laterolog and induction-based resistivity) logs. Corrections of open-hole logs for rock composition, fluid content, shaliness. The nuclear magnetic resonance log. EM wave propagation logging. Resistivity and acoustic methods for borehole imaging. Open-hole technical measurements. Production well-logging measurements in cased holes. Field studies and applications. Education method: lectures with projected PowerPoint presentation, basic practice in well log interpretation involving PC and special softwares (MATLAB, Techlog). **Competencies to evolve:** T1, T4, T5, T11, T12, K2, K4, K5, K6, K7, K9, K10, A1	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:	
• Mavko G, Mukerji T, Dvorkin J, 2009: The Rock Physics Handbook, 2nd edition, Cambridge Univ. Press. • Serra O, 1984. Fundamentals of Well-Log Interpretation. Elsevier, Amsterdam. • Ellis D V, Singer J M: Well logging for earth scientists. Springer, 2007. • Asquith, G. B, Krygowski, D., Henderson, S., & Hurley, N. (2004). Basic well log analysis. 2nd edition, American Association of Petroleum Geologists. • Rider, M. H. (1986). The geological interpretation of well logs. 2nd edition. Whittles Publishing. • Dobróka M (2014). Introduction to petrophysics physical basis. Electronic textbook.	

http://www.uni-miskolc.hu/~geofiz/education.html • Dobróka M (2014). Continuum mechanics. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/segedlet.html • Szabó N P (2014) Well-logging methods. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html
Responsible Instructor (*name, position, scientific degree):* **Mihály Dobróka Dr., professor, DSc** **Norbert Péter Szabó Dr., associate professor, PhD, Dr. habil.** **Péter Vass Dr., associate professor, PhD**

Course schedule

Date	Lecture
14 September	Petrophysical properties of rock formations. Theory of electromagnetic wave propagation in rocks.
21 September	Theory of seismic and acoustic wave propagation in rocks.
28 September	Rock mechanical studies, velocity versus pressure relationships.
5 October	Rock physical models (Hooke, Kelvin-Voigt, combined models).
12 October	First test on rock physical studies. The borehole and its environment. Petrophysical modeling of hydrocarbon formations. The classification of well-logging methods.
19 October	The basics of open-hole wireline logging methods: lithological logs (natural gamma-ray intensity, spectral gamma-ray intensity, spontaneous potential).
26 October	The basics of open-hole wireline logging methods: porosity logs (neutron-neutron, gamma-gamma, and acoustic).
Holiday	-
9 November	The basics of open-hole wireline logging methods: saturation-sensitive logs (laterolog and induction-based resistivity). Photoelectric factor logging.
16 November	Open-hole technical measurements.

23 November	Cased-hole and production well logging (PWL) methods.
30 November	Cased-hole and production well logging (PWL) methods.
7 December	Second test on well logging methods.
14 December	Repetation and improvement of writing tests.

Date	**Seminar**
14 September	Electromagnetic wave propagation in rocks (mathematical derivations).
21 September	Seismic and acoustic wave propagation in rocks (mathematical derivations).
28 September	Rock mechanical studies, velocity versus pressure relationships (mathematical derivations).
5 October	Rock physical models (mathematical derivations).
12 October	First test on rock physical studies.
19 October	Corrections of lithological logs for rock composition, fluid content, shaliness.
26 October	Corrections of porosity logs for rock composition, fluid content, shaliness.
Holiday	-
9 November	Corrections of saturation-sensitive logs for rock composition, fluid content, shaliness. Giving the assignment (one powerpoint presentation) to the students. Selection of research topics. Photoelectric factor logging.
16 November	Open-hole technical measurements.
23 November	Cased-hole and production well logging (PWL) methods.

30 November	Cased-hole and production well logging (PWL) methods.
7 December	Second test on well logging methods. Simulated conference I. Students deliver the powerpoint presentations on assigned topics. Questions and discussion. Evaluation of presentations.
14 December	Simulated conference II. Students deliver the powerpoint presentations on assigned topics. Questions and discussion. Evaluation of presentations. Repetation and improvement of writing tests.

Sample of writing test 2

1. How do we calculate the shale content of a Carboniferous sedimentary rock from the natural gamma-ray intensity log?
2. Describe the empirical response equation of the neutron-porosity tool. For what purpose do we use it in well log analysis?
3. What types of acoustic waves are measured in the borehole? How do we calculate the sonic porosity? What methods are normally used to compensate the effect of compaction?
4. How do we estimate the water saturation of shaly sandy rocks?

Solution

The answers can be found in the course material "Well-logging methods" (and the recommended literature) uploaded to the site of the Department of Geophysics:
http://www.uni-miskolc.hu/~geofiz/education.html

1. See the slide titled "Shale volume estimation" in the above course material.
2. See the slide titled "Neutron response function" in the above course material.
3. See the slides titled "Acoustic wave types", "Definition of sonic porosity", "Unconsolidated formations" and "Raymer-Hunt-Gardner equation" in the above course material.
4. See the slide titled "Water saturation of shaly sands" in the above course material.