PETROPHYSICS – WELL LOG INTERPRETATION

MSc in Petroleum Geoengineering

Second semester 2024/2025

COURSE COMMUNICATION DOCUMENT

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

Course datasheet

Course Title: Introduction to petrophysics	**Credits: 3**
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec. 2, sem. 2**	
Neptun code: MFGFT720017	
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 preparing 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): **second**	
Pre-requisites *(if any)*: **Introduction to petrophysics**	
Course Description:	
Acquired store of learning: Study goals: The course gives detailed information on well-logging and well-log interpretation techniques used in oil and gas industry. Course content: The nuclear magnetic resonance (NMR) log. The estimation of free fluid index, permeability, and pore-size distribution. Electromagnetic wave propagation (EPT) logging. Borehole radar surveys. Radar tomography. Resistivity and acoustic reflection methods for borehole imaging. Data processing steps and interpretation of borehole imaging methods. The basic approaches of the interpretation of well logs: deterministic, statistical analyses and inverse modeling. The forward problem of well logging. Tool response functions. The calculation of parameter sensitivity. Calibration of zone parameters. The local inversion of well logging data. The workflow and mathematical background. The quality check of inversion results. Estimation of clay volume, porosity, lithology, water saturation and permeability from well logs. Formation evaluation in shaly sands. Formation evaluation in unconventional formations. Education method: lectures with projected PowerPoint presentation. Solving well log analysis problems with deterministic/inversion-based methods. **Competencies to evolve:** T1, T3, T4, T5, T6, T8, T9, T12, K2, K3, K6, K7, A1	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:	
• Asquith, G. B, Krygowski, D., Henderson, S., & Hurley, N. (2004). Basic well log analysis. 2nd edition, American Association of Petroleum Geologists. • George R. C., Lizhi X., Manfred G. P., 1999. NMR Logging Principles and Applications. Halliburton. • Menke, W., 1984. Geophysical data analysis: Discrete inverse theory: Academic Press Inc. • Mayer, C., A. Sibbit, 1980. GLOBAL, a new approach to computer processed log interpretation: Proceedings of the 55th SPE Annual Fall Technical Conference and Exhibition, paper 9341, pp. 1–14.	

• Szabó N P (2014) Well-logging methods. Electronic textbook. https://exploration.uni-miskolc.hu/files/24168/Well-logging-methods.pdf
Responsible Instructor (*name, position, scientific degree):* **Norbert Péter Szabó Dr., full professor, DSc**

Course schedule

Week	Lecture
11-Feb	Integral and spectral natural gamma-ray intensity logging. Spontaneous potential logging. Gamma-gamma logging using the photoelectric effect. Determination of shale volume in sediments.
18-Feb	Density (gamma-gamma) logging. Neutron-neutron logging. Sonic logging. Determination of porosity using single well logs. Determination of porosity and lithology with the simultaneous use of well logs (i.e. cross-plot techniques). Determination of Stoneley permeability.
25-Feb	The nuclear magnetic resonance (NMR) log. The estimation of free fluid index, permeability and pore-size distribution.
3-Mar	Electromagnetic wave propagation (EPT) logging. Borehole radar surveys. Radar tomography.
11-Mar	Resistivity and acoustic reflection methods for borehole imaging.
18-Mar	Summary on well-logging methods. The basic approaches of the interpretation of well logs: deterministic, statistical analyses and inverse modeling.
25-Mar	Writing test on special well-logging methods.
1-Apr	The petrophysical (volumetric) model of hydrocarbon formations. The forward problem of well logging. Tool response functions.
8-Apr	The calculation of parameter sensitivity. The local inversion of well logging data.
15-Apr	Calibration of zone parameters. The quality check of inversion results.
22-Apr	Holiday declared by Rector.
29-Apr	Holiday declared by Rector.

6-May	Formation evaluation in shaly sands.
13-May	Formation evaluation in unconventional formations.
20-May	Writing test on interpretation methods and inversion.

Week	**Seminar**
14-Feb	The mathematical and physical background of NMR method. Data processing steps and interpretation.
21-Feb	The mathematical and physical background of EM methods and tomography. Data processing steps and interpretation.
28-Feb	Data processing steps and interpretation of borehole imaging methods.
7-Mar	The workflow and mathematical basis of deterministic modeling.
14-Mar	The workflow and mathematical basis of statistical analyses.
21-Mar	The workflow and mathematical basis of inverse modeling.
28-Mar	Computer practice on well logging inversion using MATLAB and real oilfield data. The forward problem, parametrization and linearized inversion approach.
4-Apr	Computer practice on well logging inversion using MATLAB and real oilfield data. Statistical interpretation methods.
11-Apr	The forward problem, parametrization and linearized inversion approach.
18-Apr	Good Friday.
25-Apr	Holiday declared by Rector.
2-May	No workday, no education.

9-May	Computer practice on well logging inversion using MATLAB and real oilfield data.
16-May	The calculation of estimation error of model parameters. The illustration of inversion results.
23-May	Repetation of writing tests.