WELL LOGGING COLLEGE

MS in Earth Science Engineering, Geophysical Engineering specialization

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: Optional courses - Group I Well logging college **Responsible professors**: Norbert Péter Szabó Dr., PhD, dr. habil., associate professor Péter Vass Dr., PhD, associate professor	**Code**: MFGFT730030 **Responsible Institute/Department**: Institute of Geophysics and Geoinformatics / Department of Geophysics
Semester: third	**Pre-requisites**: MFGFT7100021
Number of Contact Hours per Week: 2 lec. + 2 lab.	**Type of Assessment** (exam. / pr. mark. / other): exam (oral)
Credits: 4	**Type of Program**: full time **Program and Specializations**: MS in Earth Science Engineering, Geophysical Engineering specialization

Study goals:

In the course of the subject, the Geophysical Engineering (MSc) students will be learning about special well logging measurement, data processing and interpretation methods. The subject also serves to deepen the topic of the thesis work chosen by the student and to prepare for the final exam.

Competencies to be developed:

Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Ability: K1, K2, K3, K12, K13
Attitude: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Course content:

Special well logging methods. Lithology, porosity and saturation logs. Nuclear magnetic resonance (NMR) measurement. Estimation of effective porosity and pore-size distribution. Permeability estimation based on special well logging measurements (NMR, Stoneley wave travel time). Determination of anisotropy based on the acoustic full waveform data. Analysis of theoretical probe response functions. Solution of the well logging forward problem. Calculation of parameter sensitivity. Geophysical inversion methods used in well logging (non-linear depth-by-depth and interval inversion). Multivariate statistical analysis of well logs (factor analysis, cluster analysis). Rock typing and statistical exploration of petrophysical parameters. Studying interpretation systems used in the oil industry. Processing, analysis and evaluation of well logging datasets collected from Hungarian and international wells.

Type of assessment:

Attendance at lectures is regulated by the university code of education and examination. One writing test with satisfactory results, one individual assignment and one powerpoint presentation are the requirement of signature.

Grading scale: >86 %: excellent, 71-85 %: good, 61-70 %: medium, 46-60 %: satisfactory, <45 %: unsatisfactory.

Compulsory and recommended literature resources:
Asquith G., Krygowski D., 2004: Basic well log analysis. American Association of Petroleum Geologists (+ case studies with datasets).
Schlumberger, 1989: Log interpretation principles/applications.
Serra O., 1984. Fundamentals of well-log interpretation. Elsevier.
Ellis D. V., Singer J. M., 2007. Well logging for earth scientists, 2nd edition. Springer.
Rider M. H., 2002. The geological interpretation of well logs, 2nd Edition, Rider-French Consulting Ltd.
Szabó N. P., 2013. Well logging methods. Electric course material. http://www.uni-miskolc.hu/~geofiz/education.html.
User manuals on WellCAD, Techlog, Express, MATLAB etc. softwares.

Course schedule

Week	Lecture
1	Well-logging measurements sensitive to lithology. Integral and spectral natural gamma-ray intensity logging. Spontaneous potential logging. Gamma-gamma logging based on photoelectric effect. Determination of shale volume in sediments.
2	Well-logging measurements sensitive to porosity. Density (gamma-gamma) logging. Neutron-neutron logging. Sonic logging. Determination of Stoneley permeability.
3	Determination of porosity using single well logs. Determination of porosity and lithology with the simultaneous use of well logs (i.e. crossplot techniques). Nuclear magnetic resonance logging. Determination of NMR porosity, pore-size distribution, and permeability. The Free Fluid Index.
4	The interpretation of resistivity logs. Conventional and focused conductive logging tools. Induction logging. The Electromagnetic Propagation Tool.
5	Determination of water saturation using modified Archie's equations. The total shale model. The Dual Water model. Estimation of the invasion parameters by means of the inversion of resistivity data.
6	Borehole image logging. Resistivity, acoustic image and optical measurement techniques. Borehole radar measurements. The possibilities of radar tomography.
7	Interpretation of well logs acquired from hydrocarbon wells. Evaluation of shaly-sand reservoirs. Evaluation of complex reservoirs.
8	Hydrogeophysical well-logging methods. Evaluation of petrophysical parameters of groundwater formations. The principles and applications of engineering geophysical sounding measurements. The inversion and statistical evaluation of EGS data.
9	Interpretation of well logs acquired from mineral exploration wells. Evaluation of coals, bauxites and ores.
10	Theoretical probe response functions. Analysis of parameter sensitivity functions. Solution of the forward problem.

11	Simultaneous processing of well logs using local inverse modeling. Estimation of petrophysical parameters of hydrocarbon reservoirs. Introduction to GLOBAL and OPTIMA systems. Quality check of the estimated model.
12	Interval inversion of well logs. Estimation of rock boundary coordinates and zone parameters.
13	Multivariate statistical processing of well logs. Rock typing, estimation of petrophysical parameters using cluster analysis and factor analysis. Replacement of well logs for unmeasured intervals.
14	Schlumberger Techlog as an interpretation (software) system used in the current oilfield practice.

Week	**Practice**
1	Recommended literature. Study of special books, articles, data systems.
2	Determination of lithology using well logging data.
3	Estimation of petrophysical parameters (clay content and porosity) using well logging data.
4	Estimation of petrophysical parameters (permeability) using well logging data.
5	Estimation of petrophysical parameters (water and hydrocarbon saturation) using well logging data.
6	Short introduction to MATLAB system.
7	Computer aided well log analysis (MATLAB exercises).
8	Presentation of individual assignments, transfer of datasets. Selection of Powerpoint (ppt) presentation topics.
9	Diploma thesis consultation.
10	Diploma thesis consultation.
11	Diploma thesis consultation.

12	Simulated conference. Evaluation of Powerpoint (ppt) presentations.
13	Writing the test.
14	Submission of the individual assignments. Repeating the writing test. Presentation of the final exam's questions.

Exam questions

1. Well-logging measurements sensitive to lithology. Integral and spectral natural gamma-ray intensity logging. Spontaneous potential logging. Gamma-gamma logging based on photoelectric effect. Determination of shale volume.
2. Well-logging measurements sensitive to porosity. 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. crossplot techniques). Determination of Stoneley permeability.
3. Nuclear magnetic resonance logging. Determination of NMR porosity and permeability.
4. Well-logging measurements sensitive to saturation. Resistivity logging. Conventional and focused conductive logging tools. Induction logging. Determination of water saturation using different resistivity models.
5. Borehole image logging. Resistivity, acoustic and optical measurement techniques. Borehole radar measurements.
6. Technical measurements used in boreholes (caliper, spinner flow meter, CBL etc.). Production well-logging measurements. Logging while drilling techniques.
7. Hydrogeophysical well-logging methods. Evaluation of petrophysical parameters of aquifers.
8. Interpretation of well logs acquired from hydrocarbon wells. Evaluation of shaly-sand reservoirs. Evaluation of complex reservoirs.
9. Interpretation of well logs acquired from mineral exploration wells. Evaluation of coals, bauxites and ores.
10. Simultaneous processing of well logs using local inverse modeling. Theoretical probe response functions. Solution of the forward problem. Solution of the inverse problem. Interpretation (software) systems used in the current oilfield practice.