| 1. GENERAL INFORMATION | | | | |
|---|---|---|---|---|
| 1.1. Course teacher | Associate Professor Domagoj Vulin, PhD | | 1.6. Year of the study | II. |
| 1.2. Name of the course | PVT Characterization of reservoir fluids | | 1.7. ECTS credits | 4 |
| 1.3. Associate teachers | - | | 1.8. Type of instruction (number of hours L + E + S + e-learning) | 30L+0E+30S+0e-learning |
| 1.4. Study programme (undergraduate, graduate, integrated) | graduate | | 1.9. Expected enrolment in the course | 15 |
| 1.5. Status of the course | ☒ mandatory | ☐ elective | 1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%) | - |
| **2. COUSE DESCRIPTION** | | | | |
| 2.1. Course objectives | By taking the exam, the student will be able to use the PVT report, will know the methods and procedures of collecting PVT data and laboratory PVT analysis. Based on the above, they will be able to create a PVT model using PVT simulation software and prepare PVT data for further analytical and simulation models. | | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | Independently solve complex engineering problems in petroleum engineering and geoenergy engineering;<br>Analyse reservoir rock and reservoir fluids properties;<br>Predict reservoir behaviour and the behaviour of hydrocarbon and geothermal water production system;<br>Design system for oil and gas processing, storage and transportation. | | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | Calculate volumetric changes of real fluids by iterative procedures;<br>Identify the advantages and disadvantages of individual methods of obtaining pVT data;<br>Explain the physical relations of the parameters of cubic pVT equations of state for a real fluid;<br>Show the procedure of mathematical splitting and grouping of hydrocarbon plus fractions;<br>Devise a procedure for adjusting the parameters of the gas equation of state with a numerical pVT simulator (Schlumberger pVTi);<br>Show the structure and method of preparing and writing pVT reports;<br>Propose the method of obtaining, processing and application of pVT data on reservoir fluids for the needs of reservoir engineering;<br>Prepare the input data for the pVT simulation and modify the equation of state. | | | |

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<table>
<tr><td>2.5. Course content (syllabus)</td><td colspan="3">Measurement, processing and application of pVT data for the purpose of reservoir engineering:<br>Methods of sampling certain types of fluids; PVT experiments (by type of fluid); Theory of real gas equations used in reservoir engineering; Parameters of the respective equations; Correlations of acentric factors, definition and meaning of binary interaction parameters, volume shift. Initial assumptions of (Ki) phase equilibrium; Muscat & Mcdowell (Rachford and Rice) calculation of fluid composition during separation (two-phase range or saturation pressure boundary conditions);. Mixing rules; Mixing rule algorithms for individual parameters of the state equation; Comparison of analytically determined values with the results in PVT simulator; Calculation of PVT properties by real gas equations (made PR and SRK) for mixtures, applying RR calculations, mixing rules and equations of state; Pseudoization methods (splitting plus fractions), statistical distribution in the composition of plus fractions. Algorithm for Whitson's splitting method; Examples of different phase diagrams, depending on the type of fluid (display of phase diagrams based on typical compositions in PVT simulator); Adjustment of volume factor correlation parameters according to laboratory analysis data (development of a new correlation);<br>Calculation of the equation of state (using computer language Python):<br>Development of computer code for phase equilibria calculation; Development of computer code for calculation of real gas volume by van der Waals method; Development of computer code for calculation of real gas volume by SRK method; Development of computer code for calculation of real gas volume by PR method; Creating computer code for mixing rules; Development of computer code for calculation of phase equilibrium (quantities and component compositions of liquid and gas phase), by real gas equation; Solving convergence problems when calculating fugacity coefficients (for phase equilibrium); Development of computer code to assess the conditions of hydrate formation; Other equations (PC SAFT, BWR); Calculation of CO2 emissions by hydrocarbon combustion, based on the previously calculated composition;<br>PVT simulation:<br>Introduction to pVT simulation (Schlumberger pVTi, IPM PVTp); The usual sequence of procedures for adjusting the equation of state; Adjustment of the equation of state, ie parameters of plus fraction using pVT simulator; Simulation of pVT experiments, etc.</td></tr>
<tr><td>2.6. Format of instruction:</td><td>☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td>☒ independent assignments<br>☒ multimedia and the internet<br>☐ laboratory<br>☒ work with mentor<br>☐ (other)</td><td>2.7. Comments:<br>-</td></tr>
<tr><td>2.8. Student responsibilities</td><td colspan="3">The student should regularly attend exercises and submit a seminar paper according to the prescribed format.</td></tr>
<tr><td rowspan="2">2.9. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td>NO</td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>NO</td><td>Report</td><td></td><td>NO</td><td></td><td></td><td></td></tr>
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| | Essay | | NO | Seminar paper | YES | | | | |
| | Preliminary exam | | NO | Practical | YES | | | | |
| | Project | YES | | Written exam | | NO | ECTS credits (total) | 4 | |

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| 2.10. Required literature (available in the library and/or via other media) | **Title** | **Number of copies in the library** | **Availability via other media** |
| | Vulin, D. (2019.): Computer Assisted Characterization and Modeling of PVT Fluid Behavior, RGN Faculty (2020) | YES | YES |
| 2.11. Optional literature | Whitson, C.H., Brulé, M.R. (2000.): *Phase behavior. Richardson*, TX: Henry L. Doherty Memorial Fund of AIME, Society of Petroleum Engineers. | | |
| | Pedersen, K.S., Christensen, P.L., Shaikh, J.A., Christensen, P.L. (2006.): *Phase behavior of petroleum reservoir fluids*, CRC press. | | |
| | Robinson, D.B., Peng, D.Y. (1978.): *The characterization of the heptanes and heavier fractions for the GPA Peng-Robinson programs*, Gas processors association. | | |
| | Soave, G. (1972.): *Equilibrium constants from a modified Redlich-Kwong equation of state*, Chemical engineering science, *27*(6), 1197-1203. | | |
| 2.12. Other (as the proposer wishes to add) | The course is planned as PVT-modeling courses are structured, with emphasis on computer-assisted approach. | | |

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