TU Clausthal

# Master Studiengang
# Petroleum Engineering

## Modulhandbuch
## August 2017

# Inhaltsverzeichnis

# Common compulsory subjects of all areas of study

# Module 1: Communication Skills

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| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 1 |
| **Name of the module:** | Communication Skills |
| **Courses:** | Interpersonal Skills<br>Technical Writing |
| **Term:** | 1-2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Kraus, Mrs. Schulze-Bentrop |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems areas of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6111 Interpersonal Skills | 2V | 28/62 | 3 | 0 | 20 | 40 | 40 |
| W 9009 Technical Writing | 2Ü | 28/32 | 2 | 25 | 25 | 25 | 25 |
| Total | 2V+2Ü | 56/94 | 5 | 15 | 25 | 30 | 30 |

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| **Prerequisites for attending:** | No special prerequisites. |
| **Learning objectives / Skills:** | Strengthening and improvement of the academic and professional writing skills and ability of interpersonal communication/ Ability of students to write scientific and technical reports and to present results as well as to work in international interdisciplinary teams will be developed |
| **Course outline:** | Interpersonal Skills:<br>• Understanding yourself<br>• Building Trust: Emotional Intelligence at Work<br>• Developing Successful Interactions: Empowerment and the Involvement of Others, Conflict Management, Team Facilitation Skills<br>• Creating Learning Conversations: Providing Effective Performance Feedback, Listening and Diversity Issues<br><br>Technical Writing:<br>• Various writing exercises<br>• Working with authentic written texts, which will improve writing style, coherency, vocabulary, and grammar. |
| **Course assignments/ form of examination:** | Partial examination.<br>Interpersonal Skills:<br>Report and Presentation/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score is required to pass the written exam.<br>Technical Writing:<br>Homework Assignments/ Term paper<br>The module grade is evaluated as average grade from the both partial grades weighted by the credit point number. |
| **Media:** | • Powerpoint, White Board, Flipchart<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course |
| **Literature:** | • Lecture notes<br>• Authentic text materials<br>• Training assignments |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 2: Advanced Reservoir Mechanics

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| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 2 |
| **Name of the module:** | Advanced Reservoir Mechanics |
| **Courses:** | Thermodynamics and Phase Behavior of Hydrocarbons<br>Rock Mechanics II |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Leonhard Ganzer |
| **Lecturers:** | Prof. Ganzer, Prof. Hou |
| **Language:** | English |
| **Course type** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems areas of study |

| **Courses** | **HPW** | **Workload [h]**<br>**Contact hours/Self-study** | **CP** | **Skills**<br>**FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6104 Thermodynamics and Phase Behavior of Hydrocarbons | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| W 6234 Rock Mechanics II | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| Total | 4V+2Ü | 84/216 | 10 | 60 | 40 | | |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Ability to apply mass conservation and transfer laws as well as mathematical methods to describe phase behavior of hydrocarbons and mechanical behavior of reservoir rocks for solution of reservoir engineering problems should be developed/ Students will become capable to acquire and evaluate physical properties of reservoir fluids and rocks needed for reservoir characterization and simulation and will develop a professional expertise in the application methods for solution of real reservoir engineering problems |
| **Course outline:** | Thermodynamics and Phase Behavior of Hydrocarbons<br>• Basic Thermodynamics<br>• Physical Properties of Real Gases / Gaseous Systems<br>• Physical Properties of Liquid Systems<br>• Chemistry and Properties of Organic Components<br>• Two Phase Systems; Numerical Treatment of Real Systems<br>• Chemistry of Brines, Equilibria with Water Phases<br>• Interfacial Energy<br><br>Rock Mechanics II<br>• Poroelastic theory<br>• Borehole stability<br>• Sand production prediction<br>• Reservoir engineering applications |
| **Course assignments/ form of examination:** | Homework Assignments, Reports and presentation/ Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam.<br>The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Thermodynamics and Phase Behavior of Hydrocarbons<br>1. McCain, W. D.: Properties of Petroleum Fluids, PennWell Publishing, 1990<br>2. Whitson, C.H, Brule, M. H. Phase behavoir, SPE Monograph, vol. 20, 2000<br>3. Ahmed T.: Equationsof state and PVT Analysis. Gulf Professional Publishing, 2007<br>4. Ahmed, T.: Reservoir Engineering Handbook, Golf Professional Publishing, 2001 |

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| | Rock Mechanics II<br>1. Fjaer, E. et al. (1992): Petroleum related rock mechanics. Elsevier, Amsterdam.<br>2. Charlez, P.A. (1991): Rock Mechanics, Vol. 1 - Theoretical Fundamentals. Editions Technip, Paris.<br>3. Charlez, P.A. (1997): Rock Mechanics, Vol. 2 – Petroleum Applications. Editions Technip, Paris.<br>4. Xuan Luo & Zhengmeng Hou (2016) Automated Wellbore Stability Systems: Determination of In-situ Stresses Using Logging Data. Oil Gas European Magazine, 1/2016:20-23. Hou,<br>5. Z. & Zhou, L.: Numerical Investigation and Optimization of Multiple Fractures in Tight Gas Reservoirs. Oil Gas European Magazine 39 (3), 2013:129-135.<br>6. Zhou, L.; Hou, Z.; Gou, Y. & Li, M.T.: Numerical investigation of a low-efficient hydraulic fracturing operation in a tight gas reservoir in the North German Basin. Journal of Petroleum Science and Engineering 120(2014), August 2014:119-129, DOI:10.1016/j.petrol.2014.06.001<br>7. Hou, Z.; Gou, Y.; Taron, J.; Gorke, U.J. & Kolditz, O.: Thermo-hydro-mechanical modeling of carbon dioxide injection for enhanced gas-recovery (CO2-EGR): A benchmarking study for code comparison. Environmental Earth Sciences 67(2), 2012:549–561, DOI: 10.1007/s12665-012-1703-2. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 3: Advanced Production and Well Planning

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| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 3 |
| **Name of the module:** | Advanced Production and Well Planning |
| **Courses:** | Advanced Production<br>Well Planning |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Dr.-Ing. Perozo Baptista, Dr. Jürgen Schamp |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems areas of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6131 Advanced Production | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| W 6105 Well Planning | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | 0 |
| Total | 4V+2Ü | 84/216 | 10 | 55 | 35 | 10 | 0 |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Advanced Production:<br>Acquisition of profound knowledge in production engineering and development the ability to apply it to handle practical engineering issues like improvement of productivity and dimensioning of sub-surface and surface production facilities. /Students will became able to theoretically grasp and to practically handle sub-surface and surface petroleum production systems<br><br>Well Planning<br>Acquisition of profound knowledge in drilling engineering and the ability to apply it to the well planning/ Skills of well planning based on the profound knowledge and ability to meet requirements and options |
| **Course outline:** | Advanced Production:<br>• Introduction to integrated production systems<br>• Review of reservoir inflow characterization and modeling tools<br>• Review of multiphase flow modeling in wellbores, risers and flowlines<br>• Choke valves<br>• Surface facilities<br>• Review of production optimization techniques<br>• Diagnosis of systems performance<br>• Production allocation<br>• Linking the reservoir, the near-wellbore, the wellbore and the surface facilities<br>• Planning short-, medium- and long-term optimization of field management<br><br>Well Planning<br>• Fundamentals of Well Planning<br>• Trajectory Planning<br>• Casing and Drillstring Design<br>• Cementing<br>• BOP<br>• Examples and Case Studies |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam.<br>The module grade is evaluated as average grade from the partial grades weighted by the credit point number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory |

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| | • Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Advanced Production:<br>1. Allen, T.O. and Roberts, A.P.: Production Operations. OGCI, Tulsa, 1993.<br>2. Brill, J.B., Mukherjee H.: Multiphase Flow in Wells. SPE Monograph 17, 1999.<br>3. Cholet, H., (ed.): Well Production Practical Handbook. Editions TECHNIP, 2000<br>4. Economides, M.J., Hill, A.D. and Ehlig-Economides, C.: Petroleum Production Systems. Prentice Hall Petroleum Engineering Series, 2012.<br>5. Ikoku, C.U.: Natural Gas Engineering. Pennwell Books, 1980<br>6. Katz, D.L., et al.: Handbook of Natural Gas Engineering. Mc Graw Hill Book Company, 1959.<br>7. Reinicke, K.M., Hueni, G., Liermann, N., Oppelt J., Reichetseder, P., Unverhaun, W.: Oil and Gas – Ullmann's Encyclopedia of Industrial Chemistry - Wiley Online Library, Wiley 2014.<br>Well Planning<br>1. Aadnoy, B.S.: Modern Well Design. Rotterdam, Balkema Publications, 2010.<br>2. Lyons, W.C. (Edit.): Standard Handbook of Petroleum and Natural Gas Engineering Vol. 1 and 2. Butterworth-Heinemann, 1996.<br>3. Mitchell, R. F., Miska, S. Z.: Fundamentals of Drilling Engineering. SPE book series, 2010.<br>4. Economides, M. J., Watters L. T., Dunn-Norman, S.: Petroleum Well Construction. John Wiley & Sons, 1998 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 11: Project Management

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| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 11 |
| **Name of the module:** | Project Management |
| **Courses:** | Integrated Project Management and Development |
| **Term:** | 3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Reinicke |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems areas of study |

| **Courses** | **HPW** | **Workload [h] Contact hours/Self-study** | **CP** | **Skills FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W6117 Integrated Project Management and Development | 4V | 56/124 | 6 | 60 | 40 | 0 | 0 |

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| **Prerequisites for attending:** | No special requirements |
| **Learning objectives / Skills:** | MSc candidates should develop the ability to carry out integrated project development studies/ Skills in the application of modern techniques of engineering, systematic and creative methods of working in an international and interdisciplinary environment will be developed and established at an advanced level. |
| **Course outline:** | • System analysis: linking the reservoir, the near-wellbore, the wellbore and the surface facilities<br>• Planning short-, medium and long-term optimisation of field management<br>• Fundamentals of integrated project management<br>• Economics (Discounted Cash Flow, Elements, Indicators, Use)<br>• Data (e.g. for Development Studies: Geophysical, Geological, Well, Test, Performance Data)<br>• Data acquisition, QCing and integration (G&G, petrophysical, reservoir, well and surface facilities data)<br>• Running production forecasts and estimating reserves<br>• Case studies<br>• Application of supporting Software |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory.<br>• Video records of lectures are available with the Stud.IP course directory |
| **Literature:** | • Satter, A. und Thakur, G.: Integrated Petroleum Reservoir Management - A Team Approach. Pennwell Publishing Company, Tulsa, Oklahoma 1994<br>• SPE Reprint Series No. 48: Reservoir Management. 1998 Edition, SPE Richardson, Texas<br>• Ahmed, A., and N. Meehan: Advanced Reservoir Management and Engineering. Gulf Professional Publishing, November 2011<br>• Economides, M.J., Hill, A.D. and Ehlig-Economides, C.: Petroleum Production Systems. Prentice Hall Petroleum Engineering Series, 1994.<br>• Reinicke, K. M., Hueni, Greg, Liermann, N., Oppelt, J., Reichetseder, P., and Unverhaun, W.: Oil and Gas. Ullmann‘s Ecyclopedia of Industrial Chemistry, Online, Wiley VCH, 2013 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 13: Group Project

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| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 13 |
| **Name of the module:** | Group Project |
| **Courses:** | Group Project |
| **Term:** | 3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer (responsible for the RM area of study), Prof. Oppelt (responsible for the DP area of study), Designated faculty and research staff members (concomitant) |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems areas of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6171 Group Project | 6Ü | 84/276 | 12 | 25 | 25 | 25 | 25 |

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| **Prerequisites for attending:** | For the RM area of study at least 47 CP to achieve in the Modules 1, 2, 3, 4, 5, and 10a.<br>For the DP area of study at least 48 CP to achieve in the Modules 1, 2, 3, 7, 8, 9 and 10b.<br>For the DG area of study at least 51 CP to achieve in the Modules 1, 2, 3, 4, 7, 10a, 21<br>Admission requirements must be completed. |
| **Learning objectives / Skills:** | Consolidation of the acquired knowledge and preparation for common operational procedures of the petroleum industry by means of application of the acquired advanced knowledge to development of a solution of a real problem of the petroleum industry to be performed as interdisciplinary team work. /Advanced professional expertise in the field of petroleum engineering will be established through the application of modern techniques of engineering, systematic and creative methods of working in an international and interdisciplinary environment. |
| **Course outline:** | Preparation of an integrated field development plan on the basis of real/realistic field data, spanning - if possible:<br>• the planning cycle from seismic surveying to reservoir description and characterization,<br>• reserves evaluation,<br>• production forecasting,<br>• evaluations of health, safety and environmental impact,<br>• well planning,<br>• field development,<br>• IOR, production,<br>• marketing and economic evaluations |
| **Course assignments/ form of examination:** | Group project report + Presentation/ The overall grade of the group project is evaluated as weighted average affected by 40% of the report grade, 40 % of the presentation grade and 20 % of the team work grade. |
| **Media:** | • 3 hard copies of the group project report (to submit to the group project coordinator in due time)<br>• MS PowerPoint presentation<br>• Data CD containing soft (pdf) copies of the group project report and the presentation to submit to the group project coordinator at the project end. |
| **Literature:** | • ITE Guidelines on the preparation of technical reports and principles of scientific writing.<br>• Technical reports on the group project subjects supplied by the group project sponsors.<br>• Special literature related to the group project issues should be collected from the open sources by the group project teams.<br>• Additional data required for the project work should be identified and acquired in cooperation with the group project sponsors and coordinators by the group project team |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 14: M.Sc. Thesis + Presentation

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| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 14 |
| **Name of the module:** | M.Sc. Thesis + Colloquium |
| **Courses:** | M.Sc. Thesis + Colloquium |
| **Term:** | 4 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer (responsible for the RM area of study), Prof, Oppelt (responsible for the DP area of study), Designated faculty and scientific staff members (concomitant) |
| **Language:** | English |
| **Course:** | Compulsory subjects (PF) of the Reservoir Management, Drilling & Production and Deep Geothermal Systems of study |

| **Courses** | **HPW** | **Workload [h] Contact hours/Self-study** | **CP** | **Skills FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| Master Thesis | 16 Ab | 40/800 | 28 | 70 | 15 | 15 | 0 |

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| **Prerequisites for attending:** | More than 80 CP must be collected and all the admission requirements completed. |
| **Learning objectives / Skills:** | The MSc candidates should acquire profound professional knowledge in the field of petroleum engineering and be able to resolve complex engineering problems by using of common scientific methods of petroleum engineering/ The MSc candidates have to develop skills to present and to defend the results of their studies. |
| **Course outline:** | A problem assigned for the MSc thesis must be suited to proof the individual's ability to address a practical problem independently and in depth within of a regular time of 5 Months |
| **Course assignments/ form of examination:** | Individual assignment to an engineering or scientific problem in the field of petroleum engineering and elaboration of master thesis/ The MSc candidate must present and defend the master thesis in colloquium in presence of at least one of two designated examiners. The overall MSc thesis grade is to evaluate as weighted average affected by 90 % of the written thesis grade and 10 % of the presentation and discussion grade. |
| **Media:** | • 3 hard copies of the master thesis (to be submitted to the exam office not later than 1 week prior to the colloquium)<br>• MS PowerPoint presentation<br>• Data CD containing soft (pdf) copies of the master thesis and the presentation |
| **Literature:** | Assessment of relevant literature sources should be carried out by the MSc candidate as part of the master thesis |
| **Additional information:** | The MSc candidates are asked to agree the appointment for the colloquium with the secretary office in advance. |

# Compulsory subjects of Reservoir Management area of study

# Module 4: Data Acquisition and Evaluation

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| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 4 |
| **Name of the module:** | Data Acquisition and Evaluation |
| **Courses:** | Applied Well Test Analysis<br>Well Logging II |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ostrowski, Prof. Weller |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management area of study |

| Courses | HPW | Workload [h] Contact hours/Self-study | CP | Skills FK | MK | SK | SOK |
|---|---|---|---|---|---|---|---|
| S 6109 Applied Well Test Analysis | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| S 4023 Well Logging II | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| Total | 4V+2Ü | 84/216 | 10 | 60 | 40 | | |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | The MSc candidates should acquire the knowledge in the origination, validation, interpretation and uncertainty of engineering and geo-scientific data as well as the ability to handle, to interpolate and to extrapolate it/ Students develop skills to acquire and to evaluate data required for reservoir characterization and simulation studies. |
| **Course outline:** | Applied Well Test Analysis<br>• Objectives of Well Testing<br>• Downhole and Surface Equipment<br>• Well Test Principles, Reservoir Models, Inner & Outer Boundary Conditions<br>• Single Well Test Analysis: Drawdown, Build-Up (DST) Pulse Test, Minifrac Testing, Layered Reservoir, Vertical Interference and Horizontal Well Test<br>• Multiple Well Test Analyses: Interference Test, Pulse Interference Test; Gas Well Test Analysis Interpretation Methodology.<br>Well Logging II (cased hole logging)<br>• Introduction<br>• Radiometric methods<br>• Acoustic methods<br>• Electrical methods |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score number is required to pass the written exam. The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional well test analysis and interpretation software |
| **Literature:** | Applied Well Test Analysis<br>1. Slider, H. C.: A Simplified Method of Pressure Buildup Analysis for a Stabilized Well, Trans., AIME, 1971<br>2. Earlougher R. C.: Advances in Well Test Analysis, Monograph Series, SPE, Dallas 1977<br>3. Horner, D. R.: Pressure Analysis Methods, Reprint Series, SPE, Dallas 1967<br>4. Lee, J.: Well Testing, SPE of AIME, New York 1982<br>5. Matthews, C. S. & Russel, D. G.: Pressure Buildup and Flow Tests in Wells, Monograph Series, SPE, Dallas 1967<br>Well Logging II<br>1. Ellis, D.E.: Well Logging for Earth Scientists, Elsevier, 1987<br>2. Fricke, S.; Schön, J.: Praktische Bohrlochgeophysik, Enke, 1999 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory |

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| | at the Stud.IP |

# Module 5: Reservoir Modeling and Simulation

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| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 5 |
| **Name of the module:** | Reservoir Modelling and Simulation |
| **Courses:** | Geological Modeling<br>Numerical Reservoir Simulation |
| **Term:** | 1-2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Groß, Dipl.-Ing. Schatzmann, Prof. Ganzer, Prof. Bremeier, |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]**<br>**Contact hours/Self-study** | **CP** | **Skills**<br>**FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4820 Geological Modeling | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |
| S 6102 Numerical Reservoir Simulation | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |
| Total | 4V+2Ü | 84/216 | 10 | 50 | 30 | 20 | |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of geological and dynamic reservoir simulation models, evaluation of model uncertainties, calibration of flow models, evaluation of forecasting accuracy. / Ability of setting up and evaluate geological and dynamic reservoir simulation models as well as to approach the professional solution of real reservoir modelling and simulation problems on advanced methodical and systematical way. |
| **Course outline:** | <u>Geological Modelling:</u><br>a) Theoretical part: Interpretation and basics to reconstruct deposition areas (depositional systems and facies models) with regards to set up 3D geological models:<br>• Principles of generation of 3-D geological models<br>• Sedimentary facies<br>• Facial model<br>• Facial sequences and stratigraphy, Sedimentary structures, Well logging and facies<br>• Depositional environments: Terrestrial environments;<br>• Fluvial systems<br>• Marginal marines: Deltaic systems<br>• Example cases relevant to the petroleum geology<br><br>b) Practical part: Introduction to Petrel software package (well correlation, static geological model)<br><br><u>Numerical Reservoir Simulation:</u><br>• History and classification of reservoir simulators<br>• Review of fluid properties for simulation<br>• Rock properties and saturation functions<br>• General purpose formulation and discretization methods used for black-oil and EOS compositional simulators<br>• Gridding - structured and unstructured gridding approaches, Cartesian, corner point and Voronoi grids<br>• Modelling structural elements in simulation<br>• Representing wells in the reservoir simulation model<br>• Compositional reservoir simulation<br>• Simulation of fractured reservoirs<br>• Upgridding and upscaling<br>• History matching |
| **Course assignments/ form of examination:** | Continuous assessment and report, Project work/ Partial examination. Written (90 min) or oral exam (30-40 min). The mark of the course Geological Modelling consists of a) theoretical part -> final exam (written) and b) practical part -> continuous assessment and report. |

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| | The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Computer aided exercises using the application of the commercial reservoir modeling software PETREL (Schlumberger), Matlab and CMG<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Video records of lectures is available with the course directory on the Stud.IP |
| **Literature:** | Geological Modelling:<br>1. Magoon, L.B., Dow, W.G.: The Petroleum System. In: Magoon, L.B., Dow, W.G. (eds.) The Petroleum System – from Source to Trap, AAPG Memoir 60, 1994.<br>2. Nicols, G: Sedimentology and Stratigraphy, 2nd Edition, Wiley-Blackwell, 2009.<br>3. Slatt, G.: Stratigraphic Reservoir Characterization for Petroleum Geologists, Geophysicists, and Engineers, Volume 61, 2nd Edition, Elsevier, 2013.<br>Numerical Reservoir Simulation:<br>Aziz, K., Settari, A.: Petroleum Reservoir Simulation, Elsevier Applied Science Publishers, 1979.<br>2. Mattax, C.C., Dalton, R.L.: Reservoir Simulation, SPE Monograph Vol. 13, 1989.<br>3. Ertekin, T., Abou-Kassem, King, G. R.: Basic Applied Reservoir Simulation, SPE Textbook Vol. 7, 2001. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 6: Enhanced Hydrocarbon Recovery

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 6 |
| **Name of the module:** | Enhanced Hydrocarbon Recovery |
| **Courses:** | Enhanced Oil Recovery |
| **Term:** | 3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6103 Enhanced Oil Recovery | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the analysis and computation methods of the processes and mechanisms of the oil recovery, production and storage/ Skills in the application of the fundamentals of material and phase behavior of hydrocarbons will be consolidated and established on an advanced level |
| **Course outline:** | • Basics of Waterflooding;<br>• Chemical Flooding;<br>• Gas Flooding;<br>• Steam Flooding;<br>• Well Treatment |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | 1. Lake, L.W.: "Enhanced Oil Recovery",SPE, 2010<br>2. Green, D.W. & Willhite, G.P.: "Enhanced Oil Recovery", SPE Textbook Series, 1998.<br>3. Sheng, J.J.: "Modern Chemical Enhanced Oil Recovery", Elsevier, 2011.<br>4. Van Pollen, H. K.: "Fundamentals of Enhanced Oil Recovery", Penn Well Publishing Company, Oklahoma,1980<br>5. M. Latil: "Enhanced Oil Recovery", Gulf Publishing Company, 1980.<br>6. Dowed, T.: "Improved Oil Recovery", Interstate Oil Compact Commission, Oklahoma city, Oklahoma, (1983). |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 10 a: Economics and Law

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 10 a |
| **Name of the module:** | Management, Economics and Law |
| **Courses:** | Energy Law I<br>Planning and Budgeting |
| **Term:** | 2-3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz, Dr. Schäfer |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6168 Energy Law I | 1V | 14/46 | 2 | 60 | 40 | 0 | 0 |
| W 6114 Planning and Budgeting | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |
| Total | 3V | 42/108 | 5 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge of basics of public law and methods of business administration related to oil and gas activities including the main elements of the legal framework, planning tools and decision models / Students develop skills to understand and apply the elements of legal framework, planning tools and decision models |
| **Course outline:** | Energy Law I:<br>• Public law as basis for oil and gas activities – a general introduction<br>• Typical legal systems for upstream oil and gas activities such as Licences/Concessions, Production Sharing Agreements and Service Contracts<br>• Fiscal regimes for oil and gas activities<br>• Environmental law<br>• The legal framework of mid- and downstream oil and gas activities<br>Planning and Budgeting<br>• Basic Concepts and Definitions<br>• On Planning<br>• Vertical (Value Chain), Horizontal and Mixed Types of Business<br>• Types of Investment<br>• Evaluation of Prospects and Investments<br>• Search for and Screening of Investment Opportunities<br>• Establishing an Investment Portfolio<br>• From Portfolio to Budget Proposals<br>• The Capital Budget Decision<br>• Operational Budget and Realization<br>• Strategic Investment Plan<br>• Follow-up and Controlling |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam. The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Energy Law I<br>1. Corino, Carsten, Energy Law in Germany and its Foundations in International and European Law, Munich 2003<br>2. Kühne, Gunther, The new West German mining law, in: 19 Land and Water Law Review 1984, pp. 371-394<br>3. Respective texts of relevant laws and related documents that are provided in |

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| | the Stud.IP<br>4. Scripts on selected topics that are provided in the Stud.IP<br><br>Planning and Budgeting<br>1. Newendorp, P. D., Schuler, J. R.: Decision Analysis for Petroleum Exploration; 2nd edition. Planning Press, Tulsa, 2000.<br>2. Megill, R. E.: An Introduction to Exploration Economics. Pennwell Corp, Tulsa, 1988<br>3. Mian, M.A.: Project Economics and Decision Analysis. Pennwell Corp, Tulsa, 2011 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 12: Seminar

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 12 |
| **Name of the module:** | Seminar |
| **Courses:** | Advanced Reservoir Topics |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | All faculty and scientific staff members in the field of reservoir engineering |
| **Language:** | English |
| **Course type:** | Compulsory (PF) subjects of the Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6101 Advanced Reservoir Topics | 2S | 28/92 | 4 | 30 | 30 | 10 | 30 |

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| **Prerequisites for attending:** | No special requirements |
| **Learning objectives / Skills:** | Development the ability to apply theoretical knowledge and state-of-the-art methods and technology for the individual problem solving in the field of petroleum engineering/ Strengthening of skills to report and to present results to an audience of peers |
| **Course outline:** | Students work on assigned special topics, report and present results obtained via individual efforts within of a regular time of 6-7 weeks. |
| **Course assignments/ form of examination:** | Soft (pdf) copies of the seminar report, poster and presentation to be uploaded to the Stud.IP seminar directory in due time/<br>Seminar report, poster, presentation to an audience of peers, faculty and scientific staff members and discussion. The overall seminar grade is evaluated as weighted average affected by 40% of the report grade, 40 % of the presentation grade, 10 % of the poster grade and 10% of the moderation grade. |
| **Media:** | • DIN A3 Poster to be posted at a pin-board<br>• MS PowerPoint presentation<br>• White board |
| **Literature:** | Key literature sources should be provided by the supervisor. Assessment of further relevant literature sources should be carried out by the candidate as part of seminar study |
| **Additional information:** | Participants are requested to register for the attendance with the seminar directory at the Stud.IP |

# Compulsory subjects of Drilling & Production area of study

# Module 7: Advanced Drilling and Completion

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 7 |
| **Name of the module:** | Advanced Drilling and Completion |
| **Courses:** | Advanced Drilling Technology<br>Completion and Workover |
| **Term:** | 1-2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Thonhauser, Dr. Prohaska, Prof. Teodoriu, Dr. Bello |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Drilling&Production area of study |

| **Courses** | **HPW** | **Workload [h]**<br>**Contact hours/Self-study** | **CP** | **Skills**<br>**FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6122 Advanced Drilling Technology | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| S 6121 Completion and Workover | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| Total | 4V+2Ü | 84/216 | 10 | 60 | 40 | 0 | 0 |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | • Acquisition of profound knowledge in drilling engineering and the ability to apply it in the field of wellbore planning. Comprehension of advanced modern drilling technologies as well as merits and risks of special drilling technology to develop petroleum reservoirs efficiently<br>• Acquisition of special knowledge in the drilling, workover and completion technology to meet requirements of wellbore deliverability, safety and integrity /Skills of well planning based on the profound knowledge and ability to meet requirements and options will be extended to the advanced level and consolidated |
| **Course outline:** | Advanced Drilling Technology:<br>• Drilling concepts<br>• Well design procedure<br>• Drilling optimization<br>• Drilling performance analysis<br>• Drillstring dynamics<br>• Drilling problems<br>• HP/HT wells, horizontal and extended reach wells, multilaterals<br>• Under balanced drilling<br>• New developments in drilling operations<br>• Offshore drilling<br>• Blow out<br>• Case studies<br>Completion and Workover:<br>• Completion objectives (definition, considerations, types)<br>• Mechanical aspects of well testing<br>• Completion fluids and perforation<br>• Tubing string design<br>• Packer and downhole tools<br>• Flow control<br>• Data acquisition & inteligent completion<br>• Workover objectives & workover operations<br>• Workover rigs & tools<br>• Workover equipment (wire line, snubbing unit, coiled tubing)<br>• Completion & workover design & execution |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam.<br>The module grade is evaluated as average grade from the both partial grades weighted by the Credit point number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board |

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| | • Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Advanced Drilling Technology:<br><br>1. Aadnoy, B.S.: Modern Well Design. Rotterdam, Balkema Publications, 2010.<br>2. Aadnoy, B. S., Cooper, J., Miska, S. Z., Mitchell, R. F., Payne, M. L.: Advanced Drilling and Well Technology. SPE, 2009.<br>3. Azar, J. J., Robello Samuel, G.: Drilling Engineering. PennWell Corp., 2007<br>4. Baker, R.: A primer oilwell drilling. Publ.: Petroleum Extension Service. Univ. of Texas at Austin, Sixth Edition, Austin, Texas, 2001<br>5. Drilling_Engineering Workbook- A Distributed Learning Course. 80270H Rev. B. Baker_Hughes_INTEQ, Dec. 1995.<br>6. Economides, M. J., Watters L. T., Dunn-Norman, S.: Petroleum Well Construction. John Wiley & Sons, 1998<br>7. IADC Drilling Manual, eBook Version (V.11), International Association of Drilling Contractors, 2000.<br>8. Lyons, W.C. (Edit.): Standard Handbook of Petroleum and Natural Gas Engineering Vol. 1 and 2. Butterworth-Heinemann, 1996.<br>9. Mitchell, R. F., Miska, S. Z.: Fundamentals of Drilling Engineering. SPE book series, 2010.<br>10. Rabia, H.: Well engineering and construction. Entrac Consulting, 2001.<br><br>Completion and Workover:<br>1. Aadnoy, B.S.: Modern Well Design. Rotterdam, Balkema Publications, 2010.<br>2. Perrin, D.: Well completion and servicing - Oil and gas field development techniques, Édition Technip, 1999.<br>3. Adams, N.: Workover Well Control. PennWell Books, 1981<br>4. Bourgoyne A. T., Millheim, K. K., Chenevert, M.E., Young, F. S.: Applied Drilling Engineering, SPE Textbook Series Vol. 2, 1986.<br>5. Hill, A. D., Ding Zhu, Economides, M. J.: Multilateral Wells. SPE, 2008 |
| **Sonstiges:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 8: Directional Drilling and Logging

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 8 |
| **Name of the module:** | Directional Drilling and Logging |
| **Courses:** | Directional Drilling<br>Well Logging II |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Oppelt, Prof. Weller |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Drilling&Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6125 Directional Drilling | 2V | 28/92 | 4 | 60 | 40 | 0 | 0 |
| S 4023 Well Logging II | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| Total | 4V+1Ü | 70/200 | 9 | 60 | 40 | 0 | 0 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | • Comprehension of principles of this specialized drilling technology as well as to evaluate merits and risks of it to be able to make efficient use of it in developing reservoirs<br>• Knowledge of logging methods in cased holes and interpretation |
| **Course outline:** | Directional Drilling:<br>• Directional Drilling (Fundamentals, Planning and Design)<br>• Downhole Motors<br>• Directional Survey Methods<br>• BHAs for Well Steering<br>• Geosteering Methods<br>• Economic Aspects of Directional Drilling<br><br>Well Logging II:<br>• Fundamentals of geophysical well logging methods<br>• History – goals – technical equipment<br>• Radiometric methods<br>• Accoustic borehole measurements<br>• Electrical methods |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam. The module grade is evaluated as average grade from the both partial grades weighted by the Credit point number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | Directional Drilling:<br>1. Aadnoy, B. S., Cooper, J., Miska, S. Z., Mitchell, R. F., Payne, M. L.: Advanced Drilling and Well Technology. SPE, 2009.<br>2. Economides, M. J., Watters L. T., Dunn-Norman, S.: Petroleum Well Construction. John Wiley & Sons, 1998<br>3. Inglis, T. A.: Petroleum Engineering and Development studies, Vol. 2 Directional drilling. Springer,1987 or later<br>4. Controlled Directional Drilling. Rotary drilling series, Petroleum Extension Service (PETEX), 2009<br><br>Well Logging II<br>3. Ellis, D.E.: Well Logging for Earth Scientists, Elsevier, 1987<br>Fricke, S.; Schön, J.: Praktische Bohrlochgeophysik, Enke, 1999 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 9: Production

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 9 |
| **Name of the module:** | Production |
| **Courses:** | Advanced Hydrocarbon Conditioning and Processing I<br>Enhanced Production |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Dipl.-Ing. Waldvogel, Dr. Lungwitz |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Drilling&Production area of study |

| **Courses** | **HPW** | **Workload [h]**<br>**Contact hours/Self-study** | **CP** | **Skills**<br>**FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6110 Advanced Hydrocarbon Conditioning and Processing | 2V | 28/62 | 3 | 50 | 30 | 20 | 0 |
| S 6169 Enhanced Production | 2V | 42/78 | 4 | 60 | 40 | 0 | 0 |
| Total | 4V | 70/140 | 7 | 55 | 35 | 10 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge of techniques and design requirements for the conditioning & processing of oil & gas as well as methodologies and technologies to enhance hydrocarbon production |
| **Course outline:** | Advanced Hydrocarbon Conditioning and Processing I:<br>• Oil & Gas Processing & Equipment<br>• Process Simulation<br>• Separation & Oil Treating Facilities<br>• Heat Transfer and Facilities<br>• Pumps, Compressors & Diverters<br>• Refrigeration Systems in Gas Processing<br>• Design of Gas Dehydration Facilities<br>• Advances Sour Gas Processing and Sulphur Recovery<br>• Operation of Surface Facilities<br>• Maintenance of Surface Facilities<br>• Safety, Environment and Human Factors in Design and Operations<br>Enhanced Production:<br>• Advanced artificial lift and gas well deliquification<br>• Multiphase pumps and wet gas compressors<br>• Subsea boosting<br>• Well Stimulation<br>• Real-time flow monitoring and control<br>• Production logging |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | Advanced Hydrocarbon Conditioning and Processing I:<br>1.GPSA engineering data book 13th edition<br>2.Katz, D. Lee, R. L.: Natural gas engineering, production and storage. McGraw-Hill Publ. Co., 1990<br>3.Lake, L.W. (Ed.): Petroleum engineering handbook. Vol. III-IV, SPE, 2007.<br>Enhanced Production:<br>1. Economides, M.J., Hill, A.D. and Ehlig-Economides, C.: Petroleum Production Systems. Prentice Hall Petroleum Engineering Series, 1994<br>2. Authentic training materials of the Schlumberger Co. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory |

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| | at the Stud.IP |

# Module 10 b: Management, Economics and Law

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 10 b |
| **Name of the module:** | Management, Economics and Law |
| **Courses:** | Energy Law I<br>Planning and Budgeting<br>Health, Safety and Environmental Management |
| **Term:** | 2-3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz, Dr. Schäfer, Dipl.-Ing. Söntgerath |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Drilling&Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6168 Energy Law I | 1V | 14/46 | 2 | 60 | 40 | 0 | 0 |
| W 6114 Planning and Budgeting | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |
| W 6135 Health, Safety and Environmental Management | 1V | 14/46 | 2 | 25 | 25 | 25 | 25 |
| Summe | 4V | 56/154 | 7 | 45 | 35 | 10 | 10 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge of basics of public law, methods of business administration, health safety and environment issues related to oil and gas activities including the main elements of the legal framework, planning tools and decision models / Students develop skills to understand and apply the elements of legal framework, planning tools and decision models |
| **Course outline:** | <u>Energy Law I:</u><br>• Public law as basis for oil and gas activities – a general introduction<br>• Typical legal systems for upstream oil and gas activities such as Licenses/Concessions, Production Sharing Agreements and Service Contracts<br>• Fiscal regimes for oil and gas activities<br>• Environmental law<br>• The legal framework of mid- and downstream oil and gas activities<br><u>Planning and Budgeting</u><br>• Basic Concepts and Definitions<br>• On Planning<br>• Vertical (Value Chain), Horizontal and Mixed Types of Business<br>• Types of Investment<br>• Evaluation of Prospects and Investments<br>• Search for and Screening of Investment Opportunities<br>• Establishing an Investment Portfolio<br>• From Portfolio to Budget Proposals<br>• The Capital Budget Decision<br>• Operational Budget and Realization<br>• Strategic Investment Plan<br>• Follow-up and Controlling<br><br><u>Health, Safety and Environmental Management</u><br>• Organization of Safety and Loss Management<br>• Risk and its Management<br>• Machinery and Equipment Safety<br>• Kyoto Protocol and beyond<br>• Clear Air for Europe (CAFE)<br>• Dangerous Substances<br>• Waste and Water Management<br>• Offshore Regulations<br>• Audit - a new tool?<br>• Biodiversity - who cares? |
| **Course assignments/ form of examination:** | Homework assignments/Partial examination by disciplines. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score is required to pass the |

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| | written exam. The module grade will be evaluated as average from the partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Energy Law I<br>1. Corino, Carsten, Energy Law in Germany and its Foundations in International and European Law, Munich 2003<br>2. Kühne, Gunther, The new West German mining law, in: 19 Land and Water Law Review 1984, pp. 371-394<br>3. Respective texts of relevant laws and related documents that are provided in the Stud.IP<br>4. Scripts on selected topics that are provided in the Stud.IP<br><br>Planning and Budgeting<br>1. Newendorp, P. D., Schuler, J. R.: Decision Analysis for Petroleum Exploration; 2nd edition. Planning Press, Tulsa, 2000.<br>2. Megill, R. E.: An Introduction to Exploration Economics. Pennwell Corp, Tulsa, 1988<br>3. Mian, M.A.: Project Economics and Decision Analysis. Pennwell Corp, Tulsa, 2011<br>Health, Safety and Environmental Management<br>• Lecture notes<br>• Handouts and authentic materials based on the EU and German national health, environmental and occupational protection laws |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 12: Seminar

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 12 |
| **Name of the module:** | Seminar |
| **Courses:** | Advanced Drilling & Production Topics |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | All faculty and scientific staff members in the field of drilling and production engineering |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6120 Advanced Drilling & Production Topics | 2S | 28/92 | 4 | 30 | 30 | 10 | 30 |

| | |
|---|---|
| **Prerequisites for attending:** | No special requirements |
| **Learning objectives / Skills:** | Development the ability to apply theoretical knowledge and state-of-the-art methods and technology for the individual problem solving in the field of petroleum engineering/ Strengthening of skills to report and to present results to an audience of peers |
| **Course outline:** | Students work on assigned special topics, report and present results obtained via individual efforts within of a regular time of 6-7 weeks. |
| **Course assignments/ form of examination:** | Soft (pdf) copies of the seminar report, poster and presentation to be uploaded to the Stud.IP seminar directory in due time/<br>Seminar report, poster, presentation to an audience of peers, faculty and scientific staff members and discussion. The overall seminar grade is evaluated as weighted average affected by 40% of the report grade, 40 % of the presentation grade and 10 % of the poster grade and 10% of the moderation grade. |
| **Media:** | • DIN A3 Poster to be posted at a pin-board<br>• MS PowerPoint presentation<br>• White board |
| **Literature:** | Key literature sources should be provided by the supervisor. Assessment of further relevant literature sources should be carried out by the candidate as part of seminar study |
| **Additional information:** | Participants are requested to register for the attendance with the seminar directory at the Stud.IP |

# Compulsory subjects of Deep Geothermal Systems area of study

# Module 4: Data Acquisition and Evaluation

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| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 4 |
| **Name of the module:** | Data Acquisition and Evaluation |
| **Courses:** | Applied Well Test Analysis<br>Well Logging II |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ostrowski, Prof. Weller |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Deep Geothermal Systems area of study |

| Courses | HPW | Workload [h] Contact hours/Self-study | CP | Skills FK | MK | SK | SOK |
|---|---|---|---|---|---|---|---|
| S 6109 Applied Well Test Analysis | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| S 4023 Well Logging II | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |
| Total | 4V+2Ü | 84/216 | 10 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge in the origination, validation, interpretation and uncertainty of engineering and geo-scientific data as well as the ability to handle, to interpolate and to extrapolate it/ Students develop skills to acquire and to evaluate data required for reservoir characterization and simulation studies. |
| **Course outline:** | Applied Well Test Analysis<br>• Objectives of Well Testing<br>• Downhole and Surface Equipment<br>• Well Test Principles, Reservoir Models, Inner & Outer Boundary Conditions<br>• Single Well Test Analysis: Drawdown, Build-Up (DST) Pulse Test, Minifrac Testing, Layered Reservoir, Vertical Interference and Horizontal Well Test<br>• Multiple Well Test Analyses: Interference Test, Pulse Interference Test; Gas Well Test Analysis Interpretation Methodology.<br>Well Logging II (cased hole logging)<br>• Introduction<br>• Radiometric methods<br>• Acoustic methods<br>• Electrical methods |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam. The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional well test analysis and interpretation software |
| **Literature:** | Applied Well Test Analysis<br>6. Slider, H. C.: A Simplified Method of Pressure Buildup Analysis for a Stabilized Well, Trans., AIME, 1971<br>7. Earlougher R. C.: Advances in Well Test Analysis, Monograph Series, SPE, Dallas 1977<br>8. Horner, D. R.: Pressure Analysis Methods, Reprint Series, SPE, Dallas 1967<br>9. Lee, J.: Well Testing, SPE of AIME, New York 1982<br>10. Matthews, C. S. & Russel, D. G.: Pressure Buildup and Flow Tests in Wells, Monograph Series, SPE, Dallas 1967<br>Well Logging II<br>4. Ellis, D.E.: Well Logging for Earth Scientists, Elsevier, 1987<br>5. Fricke, S.; Schön, J.: Praktische Bohrlochgeophysik, Enke, 1999 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 7: Advanced Drilling and Completion

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 7 |
| **Name of the module:** | Advanced Drilling and Completion |
| **Courses:** | Advanced Drilling Technology<br>Completion and Workover |
| **Term:** | 1-2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Thonhauser, Dr. Prohaska, Prof. Teodoriu, Dr. Bello |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]**<br>**Contact hours/Self-study** | **CP** | **Skills**<br>**FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6122 Advanced Drilling Technology | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| S 6121 Completion and Workover | 2V+1Ü | 42/108 | 5 | 60 | 40 | 0 | 0 |
| Total | 4V+2Ü | 84/216 | 10 | 60 | 40 | 0 | 0 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | • Acquisition of profound knowledge in drilling engineering and the ability to apply it in the field of wellbore planning. Comprehension of advanced modern drilling technologies as well as merits and risks of special drilling technology to develop petroleum reservoirs efficiently<br>• Acquisition of special knowledge in the drilling, workover and completion technology to meet requirements of wellbore deliverability, safety and integrity /Skills of well planning based on the profound knowledge and ability to meet requirements and options will be extended to the advanced level and consolidated |
| **Course outline:** | Advanced Drilling Technology:<br>• Drilling concepts<br>• Well design procedure<br>• Drilling optimization<br>• Drilling performance analysis<br>• Drillstring dynamics<br>• Drilling problems<br>• HP/HT wells, horizontal and extended reach wells, multilaterals<br>• Under balanced drilling<br>• New developments in drilling operations<br>• Offshore drilling<br>• Blow out<br>• Case studies<br>Completion and Workover:<br>• Completion objectives (definition, considerations, types)<br>• Mechanical aspects of well testing<br>• Completion fluids and perforation<br>• Tubing string design<br>• Packer and downhole tools<br>• Flow control<br>• Data acquisition & intelligent completion<br>• Workover objectives & workover operations<br>• Workover rigs & tools<br>• Workover equipment (wire line, snubbing unit, coiled tubing)<br>• Completion & workover design & execution |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam.<br>The module grade is evaluated as average grade from the both partial grades weighted by the Credit point number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board |

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|---|---|
| | • Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Advanced Drilling Technology:<br><br>11. Aadnoy, B.S.: Modern Well Design. Rotterdam, Balkema Publications, 2010.<br>12. Aadnoy, B. S., Cooper, J., Miska, S. Z., Mitchell, R. F., Payne, M. L.: Advanced Drilling and Well Technology. SPE, 2009.<br>13. Azar, J. J., Robello Samuel, G.: Drilling Engineering. PennWell Corp., 2007<br>14. Baker, R.: A primer oilwell drilling. Publ.: Petroleum Extension Service. Univ. of Texas at Austin, Sixth Edition, Austin, Texas, 2001<br>15. Drilling_Engineering Workbook- A Distributed Learning Course. 80270H Rev. B. Baker_Hughes_INTEQ, Dec. 1995.<br>16. Economides, M. J., Watters L. T., Dunn-Norman, S.: Petroleum Well Construction. John Wiley & Sons, 1998<br>17. IADC Drilling Manual, eBook Version (V.11), International Association of Drilling Contractors, 2000.<br>18. Lyons, W.C. (Edit.): Standard Handbook of Petroleum and Natural Gas Engineering Vol. 1 and 2. Butterworth-Heinemann, 1996.<br>19. Mitchell, R. F., Miska, S. Z.: Fundamentals of Drilling Engineering. SPE book series, 2010.<br>20. Rabia, H.: Well engineering and construction. Entrac Consulting, 2001.<br><br>Completion and Workover:<br>6. Aadnoy, B.S.: Modern Well Design. Rotterdam, Balkema Publications, 2010.<br>7. Perrin, D.: Well completion and servicing - Oil and gas field development techniques, Édition Technip, 1999.<br>8. Adams, N.: Workover Well Control. PennWell Books, 1981<br>9. Bourgoyne A. T., Millheim, K. K., Chenevert, M.E., Young, F. S.: Applied Drilling Engineering, SPE Textbook Series Vol. 2, 1986.<br>10. Hill, A. D., Ding Zhu, Economides, M. J.: Multilateral Wells. SPE, 2008 |
| **Sonstiges:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 10 a: Economics and Law

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 10 a |
| **Name of the module:** | Management, Economics and Law |
| **Courses:** | Energy Law I<br>Planning and Budgeting |
| **Term:** | 2-3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz, Dr. Schäfer |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6168 Energy Law I | 1V | 14/46 | 2 | 60 | 40 | 0 | 0 |
| W 6114 Planning and Budgeting | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |
| Total | 3V | 42/108 | 5 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge of basics of public law and methods of business administration related to oil and gas activities including the main elements of the legal framework, planning tools and decision models / Students develop skills to understand and apply the elements of legal framework, planning tools and decision models |
| **Course outline:** | Energy Law I:<br>• Public law as basis for oil and gas activities – a general introduction<br>• Typical legal systems for upstream oil and gas activities such as Licenses/Concessions, Production Sharing Agreements and Service Contracts<br>• Fiscal regimes for oil and gas activities<br>• Environmental law<br>• The legal framework of mid- and downstream oil and gas activities<br>Planning and Budgeting<br>• Basic Concepts and Definitions<br>• On Planning<br>• Vertical (Value Chain), Horizontal and Mixed Types of Business<br>• Types of Investment<br>• Evaluation of Prospects and Investments<br>• Search for and Screening of Investment Opportunities<br>• Establishing an Investment Portfolio<br>• From Portfolio to Budget Proposals<br>• The Capital Budget Decision<br>• Operational Budget and Realization<br>• Strategic Investment Plan<br>• Follow-up and Controlling |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score number is to be collected to pass the written exam. The module grade is evaluated as average grade from the both partial grades weighted by the credit points number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Energy Law I<br>5. Corino, Carsten, Energy Law in Germany and its Foundations in International and European Law, Munich 2003<br>6. Kühne, Gunther, The new West German mining law, in: 19 Land and Water Law Review 1984, pp. 371-394<br>7. Respective texts of relevant laws and related documents that are provided in |

| | |
|---|---|
| | the Stud.IP<br>8. Scripts on selected topics that are provided in the Stud.IP<br><br>Planning and Budgeting<br>4. Newendorp, P. D., Schuler, J. R.: Decision Analysis for Petroleum Exploration; 2nd edition. Planning Press, Tulsa, 2000.<br>5. Megill, R. E.: An Introduction to Exploration Economics. Pennwell Corp, Tulsa, 1988<br>6. Mian, M.A.: Project Economics and Decision Analysis. Pennwell Corp, Tulsa, 2011 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 12: Seminar

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 12 |
| **Name of the module:** | Seminar |
| **Courses:** | Advanced Geothermal Engineering Topics |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | All faculty and scientific staff members in the field of reservoir engineering |
| **Language:** | English |
| **Course type:** | Compulsory (PF) subjects of the Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6119 Advanced Geothermal Engineering Topics | 2S | 28/92 | 4 | 30 | 30 | 10 | 30 |

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|---|---|
| **Prerequisites for attending:** | No special requirements |
| **Learning objectives / Skills:** | Development the ability to apply theoretical knowledge and state-of-the-art methods and technology for the individual problem solving in the field of petroleum engineering/ Strengthening of skills to report and to present results to an audience of peers |
| **Course outline:** | Students work on assigned special topics, report and present results obtained via individual efforts within of a regular time of 6-7 weeks. |
| **Course assignments/ form of examination:** | Soft (pdf) copies of the seminar report, poster and presentation to be uploaded to the Stud.IP seminar directory in due time/<br>Seminar report, poster, presentation to an audience of peers, faculty and scientific staff members and discussion. The overall seminar grade is evaluated as weighted average affected by 40% of the report grade, 40 % of the presentation grade, 10 % of the poster grade and 10% of the moderation grade. |
| **Media:** | • DIN A3 Poster to be posted at a pin-board<br>• MS PowerPoint presentation<br>• White board |
| **Literature:** | Key literature sources should be provided by the supervisor. Assessment of further relevant literature sources should be carried out by the candidate as part of seminar study |
| **Additional information:** | Participants are requested to register for the attendance with the seminar directory at the Stud.IP |

# Module 21: Geothermal Systems

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 14 |
| **Name of the module:** | Geothermal Systems |
| **Courses:** | Enhanced Geothermal Systems<br>Geothermal Energy Production Systems |
| **Term:** | 2-3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr.-Ing. R. Hincapie, NN |
| **Language:** | English |
| **Course type:** | Compulsory subjects (PF) of the Deep Geothermal Systems area of study |

| Courses | HPW | Workload [h] Contact hours/Self-study | CP | Skills FK | MK | SK | SOK |
|---|---|---|---|---|---|---|---|
| S 6149 Enhanced Geothermal Systems | 2V | 42/78 | 4 | 60 | 40 | 0 | 0 |
| W 6150 Geothermal Energy Production Systems | 2V | 42/78 | 4 | 60 | 40 | 0 | 0 |
| Total | 4V | 84/156 | 8 | 60 | 40 | 0 | 0 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | • Acquisition of knowledge of geothermal reservoir characterisation<br>• Acquisition of theoretical and practical knowledge of reservoir modelling and simulation techniques<br>• Theoretical and practical understanding of the geothermal production system, from reservoir to point of sale.<br>• Acquisition of knowledge of the different uses of geothermal energy: power generation, heat pumps and direct heating, combined heat and power. |
| **Course outline:** | Enhanced Geothermal Systems:<br>• Physical basis of heat transfer: fundamental terms of heat conduction, heat conduction equations, thermal properties of rocks,<br>• Terrestrial heat flow density: spatial and temporal variations,<br>• Thermal state of the earth's interior: methods of temperature determination (of uppermost crust, at great depths),<br>• Natural and technical effects to the temperature field of the subsurface, e.g. influence of meteoric water<br>• Geothermal reservoir types<br>• Concepts of geothermal systems<br>• Mathematical foundations of single and multi- phase flow in porous media<br>• Analytical and numerical methods<br>• Phase behavior<br>• Well productivity index<br>• Recovery factor<br>• Simulation<br>• Well Stimulation and engineered geothermal systems<br>Geothermal Energy Production Systems:<br>• Geothermal power generating systems: singleflash steam plants; double-flash<br>• steam plants; dry-steam plans; binary cycle power plants; advanced and hybrid systems,<br>• Field examples,<br>• Geothermal heat use without involving a power plant or a heat pump,<br>• Geothermal heat pumps,<br>• Use of spent fluids from geothermal power plants for direct use applications in so-called "cascaded" operation. |
| **Course assignments/ form of examination:** | Partial examination. Written (90 min) or oral exam (30-40 min) for each discipline.<br>At least 50% of maximal score is required to pass the written exam.<br>The module grade is evaluated as average grade from the both partial grades weighted by the Credit point number. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course |

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| | • A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | Enhanced Geothermal Systems:<br>1. Buntebarth, G. (1984): Geothermics - an introduction, Springer, Berlin<br>2. SPE.ORG the eLibrary of SPE.<br>3. Grant, M.A., Bixley, P.F. (2011): Geothermal Reservoir Engineering, 2nd Edition, Elsevier<br>4. Huenges, E. (editor) (2010): Geothermal Energy Systems: Exploration, Development, and Utilization, Wiley-VCH<br>5. Chierici G. L. (1995): Principles of Petroleum Reservoir Engineering. Springer-Verlag<br>6. Craft B.C., Hawkins, M., Terry, R.E. (1991): Applied Petroleum Reservoir Engineering, 2nd edition<br>7. Dake, L.P. (1978): Fundamentals of Reservoir Engineering. Elsevier<br><br>Geothermal Energy Production Systems:<br>1. IGA Geothermal Conference Paper Database at http://www.geothermal-energy.org/publications_and_services/conference_paper_database.html<br>2. Geothermal Energy (a Springer Open Journal) Database at http://www.geothermal-energy-journal.com/<br>3. Economides, M.J., Hill, A.D., Ehlig-Economides, C., Zhu, D. (2012): Petroleum<br>4. Production Systems, 2nd Edition, Prentice Hall<br>5. DiPippo, R. (2012): Geothermal Power Plants - Principles, Applications, Case Studies and Environmental Impact, 3rd Edition, Butterworth-Heinemann |
| **Sonstiges:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Compulsory optional subjects of Reservoir Management area of study

# Module 15.1: Petrophysics

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 15.1 |
| **Name of the module:** | Petrophysics |
| **Courses:** | Petrophysics I |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Weller |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4021 Petrophysics I | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Knowledge of geophysical rock properties and their application to the characterization of reservoirs. |
| **Course outline:** | The physical properties of rocks, their relation to other parameters and experimental procedures to derive petrophysical parameters are presented.<br>• Introduction<br>- Petrophysics in Geophysics<br>- Classification of rocks<br>- Structure and texture<br>• Pore space properties<br>- Pore space, porosity , saturation<br>- Tortuosity, constrictivity<br>- Internal surface<br>- Fractal dimension<br>• Density<br>- Density of different rocks<br>- Determination of density in laboratory, in situ and in wells<br>- Different kinds of density<br>• Magnetic Properties<br>- Para-, dia-, ferro-, and ferrimagnetism<br>- Magnetic properties of minerals and rocks<br>- Remanent magnetization<br>- The influence of temperature and pressure |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | 1. Guéguen, Y.; Palciauskas,V.: Introduction to the Physics of Rocks. Princeton University Press, 1994<br>2. Schön, J. H.: Physical Properties of Rocks. Pergamon, Oxford, 1996 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 15.2: Geostatistics

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 15.2 |
| **Name of the module:** | Geostatistics |
| **Courses:** | Advanced Geostatistics |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Mueller |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4635 Advanced Geostatistics | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

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| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge on the origination, validation, interpretation, uncertainties, spatial extrapolation and interpolation as well as the handling of the geotechnical and the geoscientific data. / Students will develop profound skills in the acquisition, evaluation of engineered and the geoscientific data required for the reservoir characterization and simulation. |
| **Course outline:** | • Introduction and Basic Concepts;<br>• Univariate Analysis;<br>• Measures of Heterogeneity;<br>• Hypothesis Tests;<br>• Bivariate Analysis;<br>• Basics of Geostatistics: Variogramme calculation and interpretation, Kriging;<br>• Use of Statistics in Petroleum Geology |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 15.3: Rock Physics

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 15.3 |
| **Name of the module:** | Rock Physics |
| **Courses:** | Advanced Rock Physics |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Wegner |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6118 Advanced Rock Physics | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the evaluation of physical properties of reservoir rocks/<br>Ability to understand and to apply the advanced techniques of reservoir rock characterization |
| **Course outline:** | • Review of rock properties and saturation functions<br>• Special and standard core analysis laboratory tests<br>• Introduction to the "Digital Rock Technology"<br>– Imaging of rocks using CT, micro-CT, FIB, etc.<br>– Generation of 3D models of rocks and single phase pore-scale simulation to derive petro physical properties of rocks such as porosity, absolute permeability, NMR, elastic properties, etc.<br>– Multiphase pore-scale simulation to derive capillary pressure and relative permeabilities<br>– Special topics: Carbonates and unconventional rocks<br>• Introduction to Microfluidic devices that resemble porous media<br>– Micro-models and Micro-fluidics – Micro-model construction, experimental setup, wettability control, etc.<br>– Investigation of EOR methods in micro-models that resemble porous media<br>– Micro-fluidic measurement devices<br>• Discussion of advantages and disadvantages of the different characterization methods<br><br><u>Exercises:</u><br>• Calculation of permeability and porosity data from laboratory flooding experiments<br>• Conversion of mico-CT to 3D models and calculation of petrophysical parameters such as porosity, permeability, grain size distribution, pore-size distribution, etc. as well as multiphase flow properties such as relative permeability and capillary pressure using the software packages Matlab, Comsol and GeoDict<br>• Comparison of laboratory flooding experiments and results obtained by Digital Rocks<br>• Evaluation of micro-model experiments |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Exercises with application of the GeoDict software in PC Pool |
| **Literature:** | Authentic lecturing an training materials, Handouts |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 15.4: Geoinformation Systems

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 15.4 |
| **Name of the module:** | Geoinformation Systems |
| **Courses:** | Geoinformation Systems |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Busch |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6340 Geoinformation Systems | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the principles of the Geo-data visualization and special application of the GIS in the oil and gas industry. |
| **Course outline:** | • Introduction GIS, what is it?; Definitions; Purpose of GIS; Solving a Problem using GIS; Special Applications from Oil and GAS Industries; Software packages<br>• Historical development Geo-data visualization, Maps; Maps and measurements; Computerization and GIS-technology<br>• Geographic Information and Spatial Data Real World Representation; Spatial phenomena; Spatial representation; Topology Time aspects; Spatial data structures; Data types; Reference frames<br>• Data capture Data input; Data preparation; Data quality<br>• GIS Functionality Basic maintenance functions; Operation types; Thematic data treatment; Spatial data analyses; Data transformation; Proximity operations Overlay and intersection ; Topological analyses and Network operations; Advanced combined functions; Procedures in integrated Data Analyses<br>• Visualization (and Mapping ) |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Exercises with application of the GIS software |
| **Literature:** | 1. Graeme F. Bonham-Carter: Geographic Information Systems for Geoscientists: Modelling with GIS.<br>2. Nicholas Chrisman: Exploring geographic information systems.<br>3. de Buy et al.: Principles of Geographic Information Systems.<br>4. Tor Bernhardsen: Geographical Information Systems.<br>5. David J. Unwin, David O'Sullivan: Geographic Information Analysis.<br>6. Michael N. DeMers: Fundamentals of Geographic Information Systems.<br>7. Laurie Kelly, Michael F. Worboys, Matt Duckham. GIS. A computing perspective.<br>8. Robert Laurini, Derek Thompson: Fundamentals of spatial information systems.<br>9. David J. Maguire, Michael F. Goodchild, David W. Rhind: Geographical Information Systems. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 16.1: Data Interpretation

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 16.1 |
| **Name of the module:** | Data Interpretation |
| **Courses:** | Applied Seismic Data Interpretation |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Haugwitz |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 4008 Applied Seismic Data Interpretation | 2V+1Ü | 42/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Theoretical knowledge about the propagation of seismic waves in the subsurface, seismic acquisition techniques and tools and main steps of seismic data processing/ Ability to understand and apply the advanced techniques of seismic data acquisition and interpretation |
| **Course outline:** | • Elements of solid earth physics;<br>• Acquisition: Seismic sources and receivers. Recording geometries, Traveltimes of refracted and reflected waves, true and apparent velocities, Moveout- and Normal Moveout-, Average-, RMS-, Stacking-,…, velocities.<br>• Processing: Signal to noise ratio, filtering, convolution and correlation, sorting in CMP-(CDP-) geometries (gathers), static corrections, NMO-corrections and stacking; signal-stretch. Zero-offset sections and the exploding reflector model. Elements of seismic migration: Migrator´s equation: ray-theoretical migration, diffractions in stacked sections; focussing diffractions to their origin.<br>• Elements of Seismic Interpretation: The theoretical (synthetic) seismogram: kinematical and dynamical aspects (traveltimes and amplitudes), vertical incidence, non-zero-offset seismograms, structural interpretation, “thin” -bed analysis; bright-, dim-, flat- spots. Elements of wavelet processing, resolution and recognition, basics of seismostratigraphy.<br>• Pitfalls in seismic interpretation: “the velocity-problem”& 2D-migration in a 3D-world. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Exercises with application of the PETREL software in PC Pool |
| **Literature:** | • Brown, A., 1991: Interpretation of 3-Dimensional Seismic Data. AAPG Mem 42, 3rd Edition, Tulsa, USA<br>• Evans, B.J., 1997: A Handbook for Seismic Data Acquisition in Exploration. Soc. Explor. Geophysicists, Tulsa<br>• Ikelle, L., & Amundsen, L., 2005: Introduction to Petroleum Seismology. Soc. Explor. Geophysicists, Tulsa<br>• Sheriff, R.E., & Geldart, L.P., 1982: Exploration Seismology. Cambridge University Press, UK<br>• Yilmaz, O., 1987: Seismic Data Processing. Soc. Explor. Geophysicists, Tulsa |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 16.2: Model Validation

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 16.2 |
| **Name of the module:** | Model Validation |
| **Courses:** | Reservoir Model Validation |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Schulze-Riegert |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6103 Reservoir Model Validation | 2V | 28/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of dynamic reservoir simulation models, evaluation of model uncertainties, calibration of flow models, evaluation of forecasting accuracy. / Ability to validate of dynamic reservoir simulation models as well as to approach the professional solution of real reservoir simulation problems on advanced methodical and systematical way. |
| **Course outline:** | • Principles of Model Validation,<br>• Subsurface Uncertainties,<br>• Multi-Dimensional Search and Solution Space,<br>• Foundations of Optimisation Methods;<br>• History Matching Inverse Problem Statement: Scope of History Matching, Bayesian Optimisation Framework;<br>• Challenges (Ill-posed problems, non-linearity of the solution space);<br>• Optimisation Approaches (manual, (semi-)automatic);<br>• Local and Global Optimisation Methods;<br>• Application of Optimisation Techniques;<br>• Model Predictions and Uncertainty Quantification. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Computer aided exercises using the application of the commercial reservoir modeling software MEPO and ECLIPSE (Schlumberger)<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. Aanonsen, S.I., Nawdal, G., Oliver, D.S., Reynolds, A.C., Valles, B.: The Ensemble Kalman Filter in Reservoir Engineering-a Review. SPEJ, Vol. 14, issue 3, 2009 or Paper SPE 117272-PA.<br>2. Begg, S.H., Bratvold, R.B., Campbell, J.M.: Improving Investment Decisions Using a Stochastic Integrated Asset Model. Paper SPE 71414, 2001.<br>3. Peake, W.T., Abadah, M., Skander, L.: Uncertainty Assessment using Experimental Design. Paper SPE 91820, 2005<br>4. Rwechungura, R. W., Dadashpour, M., Kleppe, J.: Advanced History Matching Techniques Reviewed. Paper SPE-142497-MS, 2011.<br>5. Williams, M.A., Keating, J.F., Barghouty M.F.: The Stratigraphic Method: A structured approach to History Matching. Paper SPE 38014, SPRE Vol 1, Issue 2, 1998<br>6. Yeten, B, Castellini, A., Guyaguler, B., Chen, W.H.: A Comparison Study on Experimental Design and Response Surface Methodologies. Paper SPE 93347-MS, 2005<br>7. Further recommended literature is available with the lecture notes |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 16.3: Reservoir Modeling

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 16.3 |
| **Name of the module:** | Reservoir Modeling |
| **Courses:** | Fractured Reservoir Modeling |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Mueller |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 4620 Fractured Reservoir Modeling | 2V | 28/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of geological and dynamic reservoir models, model uncertainties, calibration of flow models, evaluation of forecasting uncertainties/ Ability of setting up and evaluate of fractured reservoir models |
| **Course outline:** | • Deformation of reservoir rocks, tectonic styles;<br>• Classification, types and recording of fractures: Direct and indirect sources of information, mapping of Fracture properties;<br>• Origin of fractures, Stress field;<br>• Fracture model data base, data identification, methods of representation of fractures. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • PowerPoint presentation software and white board<br>• Computer aided exercises using the application of the commercial geological modeling and reservoir simulation software<br>• Hard copy of lecture notes will be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides will be provided on the Stud.IP directory of the course. |
| **Literature:** | |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 17.1: Natural Gas Recovery

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 17.1 |
| **Name of the module:** | Natural Gas Recovery |
| **Courses:** | Enhanced Natural Gas Recovery |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Reitenbach |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6104 Enhanced Natural Gas Recovery | 2V | 28/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in principles of analysis and engineering computation of gas recovery processes and application of material laws and phase behavior of hydrocarbons |
| **Course outline:** | • Fundamentals and Methods of EGR Processes;<br>• Enhanced Gas Recovery of Conventional Gas Reservoirs;<br>• Enhanced Natural Gas Recovery by Dense Gas Flooding;<br>• Unconventional Gas Reservoirs: Tight Gas Formations;<br>• Coal Bed Methane Recovery;<br>• Gas Hydrate Recovery and Utilization |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • PowerPoint presentation software and white board<br>• Hard copy of lecture notes will be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides will be provided on the Stud.IP directory of the course.<br>• Authentic report materials and handouts |
| **Literature:** | 1. Amix J. W., Bass Jr. D. M., Whiting R.L.: Petroleum Reservoir Engineering. McGraw Hill, NY, 1960<br>2. Katz, D., Lee, L.: Natural Gas Engineering. McGraw-Hill, 1990.<br>3. McCain Jr. W.D.: Properties of Petroleum Fluids, Penn Well, Tulsa, OK, 1990<br>4. Marle, C.M.: “Multiphase flow in porous media”, Inst. Francais du Petrol, Edition Technip, 1981<br>5. Papay, J.: Development of Petroleum Reservoirs. Academiai Kiado, Budapest, 2003.<br>6. Seidle, J.: Fundamentals of Coalbed Methane Reservoir Engineering. PennWell, 2011. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 17.2: Natural Gas Storage

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 17.2 |
| **Name of the module:** | Natural Gas Storage |
| **Courses:** | Natural Gas Storage |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Reitenbach |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6113 Natural Gas Storage | 2V | 28/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in principles of analysis, application of material laws and fundamentals of phase behavior of hydrocarbons and engineering of natural gas storage processes |
| **Course outline:** | • Media for Storage and Operation Principles;<br>• Fundamentals and definition of terms;<br>• Gas Storage in Salt Caverns: Geological, Geomechanical and Thermodynamic Conditions and Design of Caverns;<br>• Operation Fundamentals;<br>• Characteristics, Optimization Strategies;<br>• Gas Reservoirs: Reservoir Mechanics, Storage Capacity and Productivity, Gas Mixing;<br>• Well Design and Completion, Surface Installations;<br>• Aquifer Storages;<br>• Field Cases. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • PowerPoint presentation software and white board<br>• Hard copy of lecture notes will be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides will be provided on the Stud.IP directory of the course.<br>• Authentic report materials and handouts |
| **Literature:** | 1. Flanigan, O.: Underground Storage Facilities. Design and Implementation. Gulf Publishing Company, 1995.<br>2. Tek, R. M.: Natural Gas Underground Storage:Inventory and Deliverability. PennWell Publishing Company. 1996. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 17.3: Enhanced Production

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 17.3 |
| **Name of the module:** | Enhanced Production |
| **Courses:** | Enhanced Production |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Dr. Lungwitz |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6169 Enhanced Production | 2V | 42/78 | 4 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Knowledge of methodologies and technologies to enhance hydrocarbon production |
| **Course outline:** | • Advanced artificial lift and gas well deliquification<br>• Multiphase pumps and wet gas compressors<br>• Subsea boosting<br>• Well Stimulation<br>• Real-time flow monitoring and control<br>• Production logging |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min) for each discipline. At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | 1. Economides, M.J., Hill, A.D. and Ehlig-Economides, C.: Petroleum Production Systems. Prentice Hall Petroleum Engineering Series, 1994<br>2. Authentic training materials of the Schlumberger Co. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 18.1: Energy Law

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 18.1 |
| **Name of the module:** | Energy Law |
| **Courses:** | Energy Law II |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6115 Energy Law II | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Knowledge about the main contractual arrangements necessary along the value chain of oil and gas activities including the relevant regulatory framework |
| **Course outline:** | • Joint Operation Agreements as contractual arrangement within a consortium of companies<br>• Drilling Contracts and related agreements for oil and gas subsurface activities<br>• Engineering Procurement and Construction Contracts as main legal feature of oil and gas surface activities<br>• Transportation and Processing Agreements upstream<br>• Third party access and regulation in the midstream part of the value chain<br>• Gas Sales Agreements and energy supply contracts |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | 1. Armour, John, Hansmann, Henry, Kraakman, Reinier, The Essential Elements of Corporate Law: What is Corporate Law?, in: Harvard Law School, Discussion Papers no. 643, 7/2009<br>2. Allen & Overy, Basic Principles of English Cotract Law, prepared for Advocates for Development, 2016<br>3. Pieck, Manfred, A Study of the Significant Aspect of German Cotract Law, in: Annual Survey of International & Comparative Law 3 (1996) 111 et seq.<br>4. Respective internationally relevant Model Agreements and Contracts that are provided in the Stud.IP<br>5. Respective texts of relevant laws and related documents that are provided in the Stud.IP |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 18.2: Health, Safety and Environmental Management

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 18.2 |
| **Name of the module:** | Health, Safety and Environmental Management |
| **Courses:** | Health, Safety and Environmental Management |
| **Term:** | 3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Dipl.-Ing. Söntgerath |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6135 Health, Safety and Environmental Management | 1V | 14/46 | 2 | 25 | 25 | 25 | 25 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of Knowledge on Impact of Health Safety and Environment issues on oil and gas activities and ways to deal with it. |
| **Course outline:** | • Organisation of safety and loss management<br>• Risk management<br>• Machinery and equipment safety<br>• Kyoto Protocol and beyond<br>• Clear Air for Europe (CAFE)<br>• Dangerous substances<br>• Waste and water management<br>• Offshore Regulations<br>• Audit - a new tool?<br>• Biodiversity - who cares? |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | • Lecture Notes<br>• Handouts and authentic materials based on the EU and German national health, environmental and occupational protection laws |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Compulsory optional subjects of Drilling & Production area of study

# Module 19.1: Energy Law

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.1 |
| **Name of the module:** | Energy Law |
| **Courses:** | Energy Law II |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6115 Energy Law II | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Knowledge about the main contractual arrangements necessary along the value chain of oil and gas activities including the relevant regulatory framework |
| **Course outline:** | • Joint Operation Agreements as contractual arrangement within a consortium of companies<br>• Drilling Contracts and related agreements for oil and gas subsurface activities<br>• Engineering Procurement and Construction Contracts as main legal feature of oil and gas surface activities<br>• Transportation and Processing Agreements upstream<br>• Third party access and regulation in the midstream part of the value chain<br>• Gas Sales Agreements and energy supply contracts |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | 1. Armour, John, Hansmann, Henry, Kraakman, Reinier, The Essential Elements of Corporate Law: What is Corporate Law?, in: Harvard Law School, Discussion Papers no. 643, 7/2009<br>2. Allen & Overy, Basic Principles of English Cotract Law, prepared for Advocates for Development, 2016<br>3. Pieck, Manfred, A Study of the Significant Aspect of German Cotract Law, in: Annual Survey of International & Comparative Law 3 (1996) 111 et seq.<br>4. Respective internationally relevant Model Agreements and Contracts that are provided in the Stud.IP<br>5. Respective texts of relevant laws and related documents that are provided in the Stud.IP |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.2: Materials Engineering

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.2 |
| **Name of the module:** | Materials Engineering |
| **Courses:** | Materials Engineering and Corrosion |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Neubert |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6117 Materials Engineering and Corrosion | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Ability to employ appropriate materials and to design petroleum equipment and facilities |
| **Course outline:** | • Petroleum Fluids & Corrosion (Oil, Gas, Water, Emulsions, Corrosion Mechanism/Forms);<br>• Materials and corrosion<br>• Materials selection<br>• Corrosion inhibition<br>• Hydrogen corrosion<br>• Petroleum fluid and corrosion testing<br>• Cathodic corrosion protection<br>• Other protection methods |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory |
| **Literature:** | Authentic lecturing materials and handouts |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.3: Fluid Mechanics

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.3 |
| **Name of the module:** | Fluid Mechanics |
| **Courses:** | Fluid Mechanics |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Brenner |
| **Lecturers:** | Prof. Brenner |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 8040 Fluid Mechanics | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Comprehension of principles of mathematical modeling and experimental techniques to describe and to investigate fluid flow processes |
| **Course outline:** | • Properties of fluids and flows<br>• Hydrostatics, aerostatics<br>• Kinematics and dynamics of inviscid fluids –> Bernoulli equation<br>• Conservation equations of viscous fluids the Euler Equation and applications to laminar flow<br>• Conservation equations of viscous fluids the Navier- Stokes equation and applications to laminar flows<br>• Dimensional analysis<br>• Boundary layer theory<br>• Turbulent flows<br>• Experimental and measurement techniques |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory |
| **Literature:** | Authentic lecturing materials and handouts |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.4: Offshore Production and Structures

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.4 |
| **Name of the module:** | Offshore Production and Structures |
| **Courses:** | Offshore Production and Structures |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Reichetseder |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6124 Offshore Production and Structures | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Comprehension of principles and methods to evaluate and to design of the offshore production systems/Students develop skills to develop concepts and to apply the principles of the evaluation and design the elements of the offshore production systems. |
| **Course outline:** | • International Offshore Activities and Trends<br>• Design Elements (Wind, Waves, Current, Ice Forces)<br>• Ocean Floor Surveying, Platform Foundation<br>• Design of Fixed Platform Systems (Piles, Gravity)<br>• Floating Systems Dry Tree (TLP, SPAR, etc)<br>• Floating Systems Wet Tree (FPSO, Semi, etc)<br>• Subsea Completions<br>• Logistics<br>• Offshore Pipelines<br>• Actual Development Projects and Case Studies<br>• Offshore Drilling overview: floating drilling units and special equipment, jack-ups, activities |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | 1. Clauss, G., Lehmann, E., Östergaard, C., Offshore Structures, Vol. I, Conceptual Design and Hydromechanics; Springer Verlag 1992<br>2. El-Reedy, M.A., Offshore Structures - Design, Construction and Maintenance; Elsevier, 2012<br>3. Barltrop, N.D.P. (ed.), Floating Structures: a guide for design and analysis, Vol. I and II; Oilfield Publications ltd. 1998<br>4. Offshore-Magazin, http://www.offshore-mag.com |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.5: Numerical Reservoir Simulation

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 19.5 |
| **Name of the module:** | Numerical Reservoir Simulation |
| **Courses:** | Numerical Reservoir Simulation |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer, Prof. Bremeier, |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6102 Numerical Reservoir Simulation | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of dynamic reservoir simulation models, evaluation of model uncertainties, calibration of flow models, evaluation of forecasting accuracy. / Ability of setting up and evaluate dynamic reservoir simulation models as well as to approach the professional solution of real reservoir modelling and simulation problems on advanced methodical and systematical way. |
| **Course outline:** | • History and classification of reservoir simulators;<br>• Review of fluid properties for simulation - black-oil properties, equation of state; modeling rock properties and saturation functions - porosity, permeability, compressibility, relative permeability, capillary pressure, compaction, correlations;<br>• general purpose formulation and discretization methods used for black-oil and EOS compositional simulators;<br>• Gridding: structured and unstructured gridding approaches, Cartesian grids, corner point grids, Voronoi grids;<br>• Modelling structural elements in simulation - vertical and sloping faults, channels, etc.;<br>• Representing wells in the reservoir simulation model; Compositional reservoir simulation;<br>• Simulation of fractured reservoirs - numerical model, matrix-fracture exchange, recovery processes;<br>• Upgridding and upscaling;<br>• History matching |
| **Course assignments/ form of examination:** | Project work Assignments/ Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• Computer aided exercises using the application of the commercial reservoir simulation software Matlab and CMG.<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. Aziz, K., Settari, A.: Petroleum Reservoir Simulation, Elsevier Applied Science Publishers, 1979.<br>2. Mattax, C.C., Dalton, R.L.: Reservoir Simulation, SPE Monograph Vol. 13, 1989.<br>3. Ertekin, T., Abou-Kassem, King, G. R.: Basic Applied Reservoir Simulation, SPE Textbook Vol. 7, 2001. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.6: Natural Gas Storage

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.6 |
| **Name of the module:** | Natural Gas Storage |
| **Courses:** | Natural Gas Storage |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Reitenbach |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6113 Natural Gas Storage | 2V | 28/78 | 4 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in principles of analysis, application of material laws and fundamentals of phase behavior of hydrocarbons and engineering of natural gas storage processes |
| **Course outline:** | • Media for storage and operation principles;<br>• Fundamentals and definition of terms;<br>• Gas storage in salt caverns: geological, geomechanical and thermodynamic conditions and design of caverns;<br>• Operation Fundamentals;<br>• Characteristics and optimization strategies;<br>• Gas reservoirs: reservoir mechanics, storage capacity and productivity, gas mixing;<br>• Well design and completion, surface installations;<br>• Aquifer storages;<br>• Field cases. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • PowerPoint presentation software and white board<br>• Hard copy of lecture notes will be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides will be provided on the Stud.IP directory of the course.<br>• Authentic report materials and handouts |
| **Literature:** | 3. Flanigan, O.: Underground Storage Facilities. Design and Implementation. Gulf Publishing Company, 1995.<br>4. Tek, R. M.: Natural Gas Underground Storage: Inventory and Deliverability. PennWell Publishing Company. 1996. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.7: Geological Modeling

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 19.7 |
| **Name of the module:** | Geological Modeling |
| **Courses:** | Geological Modeling |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Groß, Dipl.-Ing. Schatzmann |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4820 Geological Modeling | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of geological models / Ability of setting up and evaluate geological models on advanced methodical and systematical way. |
| **Course outline:** | Geological Modelling:<br>a) Theoretical part: Interpretation and basics to reconstruct deposition areas (depositional systems and facies models) with regards to set up 3D geological models:<br>• Principles of generation of 3-D geological models<br>• Sedimentary facies<br>• Facial model<br>• Facial sequences and stratigraphy, Sedimentary structures, Well logging and facies<br>• Depositional environments: Terrestrial environments;<br>• Fluvial systems<br>• Marginal marines: Deltaic systems<br>• Example cases relevant to the petroleum geology<br><br>b) Practical part: Introduction to Petrel software package (well correlation, static geological model) |
| **Course assignments/ form of examination:** | Continuous assessment and report/ Written (90 min) or oral exam (30-40 min). The mark consists of a) theoretical part -> final exam (written) and b) practical part -> continuous assessment and report |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Computer aided exercises using the application of the commercial reservoir modeling software PETREL (Schlumberger)<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. Magoon, L.B., Dow, W.G.: The Petroleum System. In: Magoon, L.B., Dow, W.G. (eds.) The Petroleum System – from Source to Trap, AAPG Memoir 60, 1994.<br>2. Nicols, G: Sedimentology and Stratigraphy, 2nd Edition, Wiley-Blackwell, 2009.<br>3. Slatt, G.: Stratigraphic Reservoir Characterization for Petroleum Geologists, Geophysicists, and Engineers, Volume 61, 2nd Edition, Elsevier, 2013. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.8: Applied Well Test Analysis

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 19.8 |
| **Name of the module:** | Applied Well Test Analysis |
| **Courses:** | Applied Well Test Analysis |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ostrowski |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6109 Applied Well Test Analysis | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | The MSc candidates should acquire the knowledge in the origination, validation, interpretation and uncertainty of engineering and geo-scientific data as well as the ability to handle, to interpolate and to extrapolate it/ The students develop skills to acquire and to evaluate data required for reservoir characterization and simulation studies. |
| **Course outline:** | • Objectives of Well Testing<br>• Downhole and Surface Equipment<br>• Well Test Principles, Reservoir Models, Inner & Outer Boundary Conditions<br>• Single Well Test Analysis: Drawdown, Build-Up (DST) Pulse Test, Minifrac Testing, Layered Reservoir, Vertical Interference and Horizontal Well Test<br>• Multiple Well Test Analyses: Interference Test, Pulse Interference Test; Gas Well Test Analysis Interpretation Methodology. |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional well test analysis and interpretation software |
| **Literature:** | 1. Slider, H. C.: A Simplified Method of Pressure Buildup Analysis for a Stabilized Well, Trans., AIME, 1971<br>2. Earlougher R. C.: Advances in Well Test Analysis, Monograph Series, SPE, Dallas 1977<br>3. Horner, D. R.: Pressure Analysis Methods, Reprint Series, SPE, Dallas 1967<br>4. Lee, J.: Well Testing, SPE of AIME, New York 1982<br>5. Matthews, C. S. & Russel, D. G.: Pressure Buildup and Flow Tests in Wells, Monograph Series, SPE, Dallas 1967<br>6. Ramey, H. J. Jr.: Practical Use of Modern Well Test Analysis, Paper 5878, New Orleans 1976 |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.9: Enhanced Oil Recovery

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 19.9 |
| **Name of the module:** | Enhanced Oil Recovery |
| **Courses:** | Enhanced Oil Recovery |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Drilling & Production area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6103 Enhanced Oil Recovery | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the analysis and computation methods of the processes and mechanisms of the oil recovery, production and storage/ Skills in the application of the fundamentals of material and phase behavior of hydrocarbons will be consolidated and established on an advanced level |
| **Course outline:** | • Basics of Waterflooding;<br>• Chemical Flooding;<br>• Gas Flooding;<br>• Steam Flooding;<br>• Well Treatment |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **Literature:** | 1. Lake, L.W.: "Enhanced Oil Recovery",SPE, 2010<br>2. Green, D.W. & Willhite, G.P.: "Enhanced Oil Recovery", SPE Textbook Series, 1998.<br>3. Sheng, J.J.: "Modern Chemical Enhanced Oil Recovery", Elsevier, 2011.<br>4. Van Pollen, H. K.: "Fundamentals of Enhanced Oil Recovery", Penn Well Publishing Company, Oklahoma,1980<br>5. M. Latil: "Enhanced Oil Recovery", Gulf Publishing Company, 1980.<br>6. Dowed, T.: "Improved Oil Recovery", Interstate Oil Compact Commission, Oklahoma city, Oklahoma, (1983). |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 19.10: Geoinformation Systems

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 19.10 |
| **Name of the module:** | Geoinformation Systems |
| **Courses:** | Geoinformation Systems |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Busch |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Reservoir Management area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6340 Geoinformation Systems | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the principles of the Geo-data visualization and special application of the GIS in the oil and gas industry. |
| **Course outline:** | • Introduction GIS, what is it?; Definitions; Purpose of GIS; Solving a Problem using GIS; Special Applications from Oil and GAS Industries; Software packages<br>• Historical development Geo-data visualization, Maps; Maps and measurements; Computerization and GIS-technology<br>• Geographic Information and Spatial Data Real World Representation; Spatial phenomena; Spatial representation; Topology Time aspects; Spatial data structures; Data types; Reference frames<br>• Data capture Data input; Data preparation; Data quality<br>• GIS Functionality Basic maintenance functions; Operation types; Thematic data treatment; Spatial data analyses; Data transformation; Proximity operations Overlay and intersection; Topological analyses and Network operations; Advanced combined functions; Procedures in integrated Data Analyses<br>• Visualization (and Mapping ) |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Exercises with application of the GIS software |
| **Literature:** | 1. Graeme F. Bonham-Carter: Geographic Information Systems for Geoscientists: Modelling with GIS.<br>2. Nicholas Chrisman: Exploring geographic information systems.<br>3. de Buy et al.: Principles of Geographic Information Systems.<br>4. Tor Bernhardsen: Geographical Information Systems.<br>5. David J. Unwin, David O'Sullivan: Geographic Information Analysis.<br>6. Michael N. DeMers: Fundamentals of Geographic Information Systems.<br>7. Laurie Kelly, Michael F. Worboys, Matt Duckham. GIS. A computing perspective.<br>8. Robert Laurini, Derek Thompson: Fundamentals of spatial information systems.<br>9. David J. Maguire, Michael F. Goodchild, David W. Rhind: Geographical Information Systems. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Compulsory optional subjects of Deep Geothermal Systems area of study

# Module 20.1: Energy Law

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 20.1 |
| **Name of the module:** | Energy Law |
| **Courses:** | Energy Law II |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Prof. Wolkewitz |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6115 Energy Law II | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Knowledge about the main contractual arrangements necessary along the value chain of oil and gas activities including the relevant regulatory framework |
| **Course outline:** | • Joint Operation Agreements as contractual arrangement within a consortium of companies<br>• Drilling Contracts and related agreements for oil and gas subsurface activities<br>• Engineering Procurement and Construction Contracts as main legal feature of oil and gas surface activities<br>• Transportation and Processing Agreements upstream<br>• Third party access and regulation in the midstream part of the value chain<br>• Gas Sales Agreements and energy supply contracts |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | 6. Armour, John, Hansmann, Henry, Kraakman, Reinier, The Essential Elements of Corporate Law: What is Corporate Law?, in: Harvard Law School, Discussion Papers no. 643, 7/2009<br>7. Allen & Overy, Basic Principles of English Cotract Law, prepared for Advocates for Development, 2016<br>8. Pieck, Manfred, A Study of the Significant Aspect of German Cotract Law, in: Annual Survey of International & Comparative Law 3 (1996) 111 et seq.<br>9. Respective internationally relevant Model Agreements and Contracts that are provided in the Stud.IP<br>10. Respective texts of relevant laws and related documents that are provided in the Stud.IP |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.2: Fluid Mechanics

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 20.3 |
| **Name of the module:** | Fluid Mechanics |
| **Courses:** | Fluid Mechanics |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Brenner |
| **Lecturers:** | Prof. Brenner |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 8040 Fluid Mechanics | 2V | 28/62 | 3 | 60 | 40 | 0 | 0 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Comprehension of principles of mathematical modeling and experimental techniques to describe and to investigate fluid flow processes |
| **Course outline:** | • Properties of fluids and flows<br>• Hydrostatics, aerostatics<br>• Kinematics and dynamics of inviscid fluids –> Bernoulli equation<br>• Conservation equations of viscous fluids the Euler Equation and applications to laminar flow<br>• Conservation equations of viscous fluids the Navier- Stokes equation and applications to laminar flows<br>• Dimensional analysis<br>• Boundary layer theory<br>• Turbulent flows<br>• Experimental and measurement techniques |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory |
| **Literature:** | Authentic lecturing materials and handouts |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.3: Numerical Reservoir Simulation

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 20.3 |
| **Name of the module:** | Numerical Reservoir Simulation |
| **Courses:** | Numerical Reservoir Simulation |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Ganzer, Prof. Bremeier, |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6102 Numerical Reservoir Simulation | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of dynamic reservoir simulation models, evaluation of model uncertainties, calibration of flow models, evaluation of forecasting accuracy. / Ability of setting up and evaluate dynamic reservoir simulation models as well as to approach the professional solution of real reservoir modelling and simulation problems on advanced methodical and systematical way. |
| **Course outline:** | • History and classification of reservoir simulators;<br>• Review of fluid properties for simulation - black-oil properties, equation of state; modeling rock properties and saturation functions - porosity, permeability, compressibility, relative permeability, capillary pressure, compaction, correlations;<br>• general purpose formulation and discretization methods used for black-oil and EOS compositional simulators;<br>• Gridding: structured and unstructured gridding approaches, Cartesian grids, corner point grids, Voronoi grids;<br>• Modelling structural elements in simulation - vertical and sloping faults, channels, etc.;<br>• Representing wells in the reservoir simulation model; Compositional reservoir simulation;<br>• Simulation of fractured reservoirs - numerical model, matrix-fracture exchange, recovery processes;<br>• Upgridding and upscaling;<br>• History matching |
| **Course assignments/ form of examination:** | Project work Assignments/ Written (90 min) or oral exam (30-40 min). 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• Computer aided exercises using the application of the commercial reservoir simulation software Matlab and CMG.<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. Aziz, K., Settari, A.: Petroleum Reservoir Simulation, Elsevier Applied Science Publishers, 1979.<br>2. Mattax, C.C., Dalton, R.L.: Reservoir Simulation, SPE Monograph Vol. 13, 1989.<br>3. Ertekin, T., Abou-Kassem, King, G. R.: Basic Applied Reservoir Simulation, SPE Textbook Vol. 7, 2001. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.4: Geological Modeling

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 20.4 |
| **Name of the module:** | Geological Modeling |
| **Courses:** | Geological Modeling |
| **Term:** | 1/3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Groß, Dipl.-Ing. Schatzmann |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4820 Geological Modeling | 2V+1Ü | 42/108 | 5 | 50 | 30 | 20 | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the field of setting up of geological models / Ability of setting up and evaluate geological models on advanced methodical and systematical way. |
| **Course outline:** | Geological Modelling:<br>a) Theoretical part: Interpretation and basics to reconstruct deposition areas (depositional systems and facies models) with regards to set up 3D geological models:<br>• Principles of generation of 3-D geological models<br>• Sedimentary facies<br>• Facial model<br>• Facial sequences and stratigraphy, Sedimentary structures, Well logging and facies<br>• Depositional environments: Terrestrial environments;<br>• Fluvial systems<br>• Marginal marines: Deltaic systems<br>• Example cases relevant to the petroleum geology<br><br>b) Practical part: Introduction to Petrel software package (well correlation, static geological model) |
| **Course assignments/ form of examination:** | Continuous assessment and report/ Written (90 min) or oral exam (30-40 min). The mark consists of a) theoretical part -> final exam (written) and b) practical part -> continuous assessment and report |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Computer aided exercises using the application of the commercial reservoir modeling software PETREL (Schlumberger)<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 4. Magoon, L.B., Dow, W.G.: The Petroleum System. In: Magoon, L.B., Dow, W.G. (eds.) The Petroleum System – from Source to Trap, AAPG Memoir 60, 1994.<br>5. Nicols, G: Sedimentology and Stratigraphy, 2nd Edition, Wiley-Blackwell, 2009.<br>6. Slatt, G.: Stratigraphic Reservoir Characterization for Petroleum Geologists, Geophysicists, and Engineers, Volume 61, 2nd Edition, Elsevier, 2013. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.5: Hydrogeology for the Geothermal Energy Production

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|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 20.5 |
| **Name of the module:** | Hydrogeology for the Geothermal Energy Production |
| **Courses:** | Hydrogeology for the Geothermal Energy Production |
| **Term:** | 2 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. C. Hansen |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| S 6145 Hydrogeology for the Geothermal Energy Production | 1V+1Ü | 28/92 | 3 | 60 | 30 | | 10 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | • Acquisition of knowledge in hydrological relevant tasks in the development and processes of geothermal reservoirs |
| **Course outline:** | • Introduction to hydrogeology and water cycle,<br>• Hydrological rock properties, water flow in porous and fractures aquifers,<br>• Darcy's law and groundwater flow equation, groundwater modelling with MODFLOW,<br>• Introduction to hydrochemistry, water composition: major, minor and trace<br>• elements, Sampling techniques, application of tracer, water pollutants,<br>• Hydro-chemical characterisation of groundwater levels,<br>• Thermodynamic fundamentals for hydro-geochemical modelling, training on the software PHREEQC, solubility of minerals, scaling in geothermal facilities, thermodynamic databases, introduction of the software PHAST. |
| **Course assignments/ form of examination:** | Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. Fetter, C.W. (2001): Applied Hydrogeology<br>2. Kresic, N. (1997): Quantitative solutions in hydrogeology and groundwater modeling<br>3. Stumm, W., Morgan, J.J. (1981): Aquatic chemistry – an introduction emphasizing chemical equilibria in natural waters |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| | |

# Module 20.6: Geothermal Geology

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 20.6 |
| **Name of the module:** | Geothermal Geology |
| **Courses:** | Geothermal Geology |
| **Term:** | 1-3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. M. Dussel |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h] Contact hours/Self-study** | **CP** | **Skills FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 4660 Geothermal Geology | 1V+1Ü | 28/92 | 4 | 60 | 35 | | 5 |

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|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | A clear understanding of the different types of geothermal resources, how they can be found and in which geological settings. |
| **Course outline:** | • Description of a comprehensive range of Geothermal Play Types in terms of generic conceptual models of geological and tectonic settings in which geothermal systems might naturally develop or be engineered around the world.<br>• Terminology and definitions for a classification framework for Geothermal Potential (resource/reserve). |
| **Course assignments/ form of examination:** | Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | 1. IGA Geothermal Conference Paper Database: http://www.geothermal-energy.org/publications_and_services/conference_paper_database.html<br>2. Geothermal Energy (a Springer Open Journal) Database: http://www.geothermal-energy-journal.com/ |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.7: Fossil & Renewable Energy

| | |
|---|---|
| **Degree Programme:** | Petroleum Engineering |
| **Module number:** | 20.7 |
| **Name of the module:** | Fossil & Renewable Energy |
| **Courses:** | Fossil & Renewable Energy |
| **Term:** | 1-3 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Dr. Buddenberg |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 8831 Fossil & Renewable Energy | 2V+1Ü | 42/108 | 5 | 60 | 35 | | 5 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | A clear understanding of the different types of fossil and renewable resources, how they can be found and in which geological settings. |
| **Course outline:** | • Basics of energy: definitions physical, technical and economic fundamentals<br>• Fossil (and nuclear) Resources<br>• Renewable Resources<br>• Energy scenarios |
| **Course assignments/ form of examination:** | Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **Literature:** | |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.8: Health, Safety and Environmental Management

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 20.8 |
| **Name of the module:** | Health, Safety and Environmental Management |
| **Courses:** | Health, Safety and Environmental Management |
| **Term:** | 3 |
| **Person responsible for the module:** | Prof. Oppelt |
| **Lecturers:** | Dipl.-Ing. Söntgerath |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6135 Health, Safety and Environmental Management | 1V | 14/46 | 2 | 25 | 25 | 25 | 25 |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of knowledge on impact of health safety and environment issues on oil and gas activities and ways to deal with it. |
| **Course outline:** | • Organisation of Safety and Loss Management<br>• Risk and its Management<br>• Machinery and Equipment Safety<br>• Kyoto Protocol and beyond<br>• Clear Air for Europe (CAFE)<br>• Dangerous Substances<br>• Waste and water Management<br>• Offshore Regulations<br>• Audit - a new tool?<br>• Biodiversity - who cares? |
| **Course assignments/ form of examination:** | Homework assignments/ Written (90 min) or oral exam (30-40 min). At least 50% of maximal score number is required to pass the written exam. |
| **Media:** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Hard copy of lecture notes to be provided at the beginning of the course<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Video records of lectures available with the Stud.IP course directory |
| **Literature:** | • Lecture Notes<br>• Handouts and authentic materials based on the EU and German national health, environmental and occupational protection laws |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

# Module 20.9: Geoinformation Systems

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|---|---|
| **Degree Programme:** | Petroleum Engineering (M.Sc.) |
| **Module number:** | 20.9 |
| **Name of the module:** | Geoinformation Systems |
| **Courses:** | Geoinformation Systems |
| **Term:** | 1 |
| **Person responsible for the module:** | Prof. Ganzer |
| **Lecturers:** | Prof. Busch |
| **Language:** | English |
| **Course type:** | Compulsory optional subjects (WPF) of Deep Geothermal Systems area of study |

| **Courses** | **HPW** | **Workload [h]** **Contact hours/Self-study** | **CP** | **Skills** **FK** | **MK** | **SK** | **SOK** |
|---|---|---|---|---|---|---|---|
| W 6340 Geoinformation Systems | 2V+1Ü | 42/108 | 5 | 60 | 40 | | |

| | |
|---|---|
| **Prerequisites for attending:** | No special prerequisites |
| **Learning objectives / Skills:** | Acquisition of advanced knowledge in the principles of the Geo-data visualization and special application of the GIS in the oil and gas industry. |
| **Course outline:** | • Introduction GIS, what is it?; Definitions; Purpose of GIS; Solving a Problem using GIS; Special Applications from Oil and GAS Industries; Software packages<br>• Historical development Geo-data visualization, Maps; Maps and measurements; Computerization and GIS-technology<br>• Geographic Information and Spatial Data Real World Representation; Spatial phenomena; Spatial representation; Topology Time aspects; Spatial data structures; Data types; Reference frames<br>• Data capture Data input; Data preparation; Data quality<br>• GIS Functionality Basic maintenance functions; Operation types; Thematic data treatment; Spatial data analyses; Data transformation; Proximity operations Overlay and intersection; Topological analyses and Network operations; Advanced combined functions; Procedures in integrated Data Analyses<br>• Visualization (and Mapping ) |
| **Course assignments/ form of examination:** | Module exam. Written (90 min) or oral exam (30-40 min). |
| **Media:** | • Multimedia lecturing tools<br>• Hard copy of lecture notes to be provided at the beginning of the course.<br>• Video records of lecture available with the Stud.IP directory of the course.<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course.<br>• Exercises with application of the GIS software |
| **Literature:** | 1. Graeme F. Bonham-Carter: Geographic Information Systems for Geoscientists: Modelling with GIS.<br>2. Nicholas Chrisman: Exploring geographic information systems.<br>3. De Buy et al.: Principles of Geographic Information Systems.<br>4. Tor Bernhardsen: Geographical Information Systems.<br>5. David J. Unwin, David O'Sullivan: Geographic Information Analysis.<br>6. Michael N. DeMers: Fundamentals of Geographic Information Systems.<br>7. Laurie Kelly, Michael F. Worboys, Matt Duckham. GIS. A computing perspective.<br>8. Robert Laurini, Derek Thompson: Fundamentals of spatial information systems.<br>9. David J. Maguire, Michael F. Goodchild, David W. Rhind: Geographical Information Systems. |
| **Additional information:** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

## List of Abbreviations

Workload units:
HPW Hours per week
CP ECTS Credit Point

Course type:
(PF) Compulsory subject
(WPF) Compulsory optional subject
(WF) Elective (additional exam)

Teaching form:
V Lecture
Ü Exercise
V + Ü Lecture and exercise
P Practical training
S Seminar

Type of Exam:
(K) Written exam
(M) Oral exam
(Th) Term paper
(Ab) Master thesis + Colloquium
(SL) Seminar paper + Presentation

Skills:
FK Professional skills
MK Technical skills
SK System expertise
SOK Social skills