
# Modulhandbuch des Masterstudiengangs Petroleum Engineering

basierend auf den Ausführungsbestimmungen vom 21.06.2022

zuletzt geändert am 21.06.2022

Stand: 02.11.2022

# Inhaltsverzeichnis

# Abkürzungsverzeichnis

| | |
|---|---|
| B.Sc. | Bachelor of Science |
| BA | Bachelorarbeit |
| E | Exkursion |
| h | Stunden |
| LN | Leistungsnachweis |
| LP | Leistungspunkte gemäß European Credit Transfer System |
| LV | Lehrveranstaltung |
| M.Sc. | Master of Science |
| MA | Masterarbeit |
| MP | Modulprüfung |
| MTP | Modulteilprüfung |
| P | Praktikum |
| PV | Prüfungsvorleistung |
| S | Seminar |
| SS | Sommersemester |
| SWS | Semesterwochenstunden |
| T | Tutorium |
| Ü | Übung |
| V | Vorlesung |
| WS | Wintersemester |

# Pflichtmodule

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Soft Skills |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>4 | **8. Dauer**<br>[ ] 1 Semester<br>[X] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |
| **10. Lern-/Qualifikationsziele des Moduls**<br>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. | | | |

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Interpersonal Skills | Prof. Kraus | S 6111 | V | 2 | 28 h / 62 h |
| **2** | Technical Writing | Mrs. Schulze-Bentrop | W 9009 | Ü | 2 | 28 h / 32 h |
| | | | | **Summe:** | 4 | 56 h / 94 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites. |
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| **19a. Inhalte** | • **Understanding yourself**<br>You will learn more about your personal profile by referring to a profile e.g. Comprofiles<br><br>• **Building Trust: Emotional Intelligence at Work**<br>You will learn how to manage your emotions by better understanding the following aspects:<br>- Empathy: How to read your counterpart<br>- Self regulation: How to control your emotions<br>- Communication: How to improve your communication skills<br>-<br>• **Developing Successful Interactions:**<br>You will learn how to Empower and Involve Others by understanding group dynamics, Conflict Management and Team Facilitation Skills<br>You will learn communication models e.g. 4-Ears, 5 Axioms from Paul Watzlawick, Ego-States from Eric Berne. You will also learn how intercultural differences are influencing social interaction.<br><br>• **Creating Learning Conversations:**<br>You will learn how to provide effective Performance Feedback, how to better understand by listening. We will talk how sociological interactions are influencing your behaviour |
| **20a. Medienformen** | • Powerpoint, White Board, Flipchart<br>• Online-Course<br><br>A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course |
| **21a. Literatur** | • Lecture notes<br>• Authentic text materials<br>• Training assignments<br><br>Georg Kraus with mit Christel Becker-Kolle, Thomas Fischer: Handbook Change Management: Management of Change Processes in Organizations Influencing Factors and Parties Involved Concepts, Instruments and Methods, ISBN 978-3-746-07122-0.<br><br>Daniel Goleman Emotional Intelligence: Why It Can Matter More Than IQ, ISBN 978-0553840070<br><br>Charles Hampden-Turner and Fons Trompenaars<br>Riding the Waves of Culture: Understanding Diversity in Global Business: Understanding Cultural Diversity in Business<br>ISBN 978-1529346183<br><br>Geert Hofstede Cultures and Organizations - Software of the Mind: Intercultural Cooperation and Its Importance for Survival, ISBN 978-0071664189<br><br>Eric Berne Games People Play: The Psychology of Human Relationships, ISBN 978-0241257470 |

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| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites. |
| **19b. Inhalte** | Various writing exercises. Working with authentic written texts, which will improve writing style, coherency, vocabulary, and grammar. |
| **20b. Medienformen** | • Powerpoint, White Board, Flipchart<br>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course |
| **21b. Literatur** | • Lecture notes<br>• Authentic text materials<br>Training assignments |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Interpersonal Skills | MTP | 2 | graded | 50 % |
| 2 | Technical Writing | MTP | 2 | graded | 50 % |

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|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Interpersonal Skills:<br>Report and Presentation/ Written (90 – 120 min) or oral exam (20-60 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Kraus/ Mrs. Schulze-Bentrop |
| **31. Prüfungsvorleistungen** | None |

| 1a. Modultitel (deutsch) | 1b. Modultitel (englisch) |
|---|---|
| | Reservoir Management, Economics and Law |

**2. Verwendbarkeit des Moduls in Studiengängen**

M.Sc. Petroleum Engineering

| 3. Modulverantwortliche(r) | | 4. Zuständige Fakultät | 5. Modulnummer |
|---|---|---|---|
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 8 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Field Management and Surveillance:

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.

Health, safety and Environmental Management:

Comprehension of impact of health safety and environmental issues on the oil and gas activities and ways to deal with it / Students develop skills to understand and apply the elements of legal framework, planning tools and decision models.

Planning and Budgeting:

Ability to grasp the planning and budgeting concepts with a special focus on the oil and gas applications.

Energy Law:

Acquisition of knowledge of the public law basics of oil and gas activities including the main elements of the legal framework

Acquisition of knowledge about the main contractual arrangements necessary along the value chain of oil and gas activities including the relevant regulatory framework

**Lehrveranstaltungen**

| 11. Nr. | 12. Lehrveranstaltungstitel (deutsch/englisch) | 13. Dozent(in) | 14. LV-Nr. | 15. LV-Art | 16. SWS | 17. Arbeitsaufwand Präsenz-/Eigenstudium |
|---|---|---|---|---|---|---|

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|---|---|---|---|---|---|---|
| **1** | Field Management and Surveillance | Dr. Ülker | W 6166 | V+Ü | 2 | 28 h / 62 h |
| **2** | Health, Safety and Environmental Management | Dipl.-Ing. Söntgerath | W 6135 | V | 1 | 14 h / 46 h |
| **3** | Planning and Budgeting | Dr. Schäfer | W 6114 | V | 2 | 28 h / 62 h |
| **4** | Energy Law | Prof. Wolkewitz | S 6168 | V | 2 | 28 h /62 h |
| | | | | **Summe:** | 7 | 98 h / 232 h |

| **Zu Nr. 1:** | |
|---|---|
| **18a. Empf. Voraussetzungen** | No special prerequisites. |
| **19a. Inhalte** | • What do we mean by "Reservoir Management"?<br>• What is new in Reservoir Management?<br>• Reservoir Characterisation<br>• Reservoir Management Process<br>• The Technology Toolkit: Understanding the Reservoir<br>• Recovery Methods<br>• Well Management<br>• Adding Economic Value<br>• Practical Exercises |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory. |
| **21a. Literatur** | • 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites. |
| **19b. Inhalte** | • 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? |

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| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21b. Literatur** | • Lecture notes<br>• Handouts and authentic materials based on the EU and German national health, environmental and occupational protection laws |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | No special prerequisites. |
| **19c. Inhalte** | • 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 |
| **20c. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21c. Literatur** | • Newendorp, P. D., Schuler, J. R.: Decision Analysis for Petroleum Exploration; 2nd edition. Planning Press, Tulsa, 2000.<br>• Megill, R. E.: An Introduction to Exploration Economics. Pennwell Corp, Tulsa, 1988<br>• Mian, M.A.: Project Economics and Decision Analysis. Pennwell Corp, Tulsa, 2011 |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 4:** | |
| **18d. Empf. Voraussetzungen** | No special prerequisites. |

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| **19d. Inhalte** | • Public law as basis for oil and gas activities – a general introduction (2 Chapter)<br>• Typical legal systems for upstream oil and gas activities such as Licenses/Concessions, Production Sharing Agreements and Service Contracts including respective fiscal regimes (2 Chapter)<br>• Environmental law (2 Chapter)<br>• Joint Operation Agreements as contractual arrangement within a consortium of companies (1 Chapter)<br>• Drilling Contracts and related agreements for oil and gas subsurface activities (1 Chapter)<br>• Engineering Procurement and Construction Contracts as main legal feature of oil and gas surface activities (1 Chapter)<br>• Transportation and Processing Agreements upstream (1 Chapter)<br>• Third party access and regulation in the midstream part of the value chain (1 Chapter)<br>• Gas Sales Agreements and energy supply contracts (1 Chapter)<br>• Public international law aspects including investment protection (2 Chapter) |
| **20d. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21d. Literatur** | • Corino, Carsten, Energy Law in Germany and its Foundations in International and European Law, Munich 2003<br>• Kühne, Gunther, The new West German mining law, in: 19 Land and Water Law Review 1984, pp. 371-394<br>• Respective texts of relevant laws and related documents that are provided in the Stud.IP<br>• Scripts on selected topics that are provided in the Stud.IP |
| **22d. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Field Management and Surveillance | MTP | 2 | graded | 25 % |
| **2** | Health, Safety and Environmental Management | MTP | 2 | graded | 25 % |
| **3** | Planning and Budgeting | MTP | 2 | graded | 25 % |
| **4** | Energy Law | MTP | 2 | graded | 25 % |

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|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Reservoir Management and Surveillance:<br>Partial exam. Written (90 -120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam.<br>Health, Safety and Environmental Management:<br>Partial exam. Homework assignments/Partial examination by disciplines. Written (90 – 120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam.<br>Planning and Budgeting:<br>Partial exam. Written (90 – 120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam.<br>Energy Law:<br>Partial exam. Homework assignments/Partial examination by disciplines. Written (90 – 120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam.<br><br>The module grade will be evaluated as average from the partial grades weighted by the credit points number. |
| **30. Verantwortliche(r) Prüfer(in)** | Dr. Ülker / Dipl.-Ing. Söntgerath / Dr. Schäfer / Prof. Wolkewitz |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Fluid Phase and Flow Behaviour |

**2. Verwendbarkeit des Moduls in Studiengängen**

M.Sc. Petroleum Engineering

| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
|---|---|---|---|
| Prof. Dr.-Ing. Philip Jaeger | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 10 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Students

- calculate with different physical laws and understand the physical background.
- qualify and quantify the phase behavior of pure substances and multicomponent systems.
- know specific petroleum and natural gas relevant material systems.
- name and describe different measurement techniques for determining physicochemical properties of single- and multi-component systems.
- understand the structure and sequence of various engineering processes.
- analyze the effects of external influencing factors on various material properties.
- draw conclusions from the change in various material properties with regard to the stability of multiphase systems and the mutual interactions of the single phases.
- reduce a complex problem to the content required to solve the problem.
- are able to interpret the fundamental conservation equations of fluid mechanics.
- know and understand numerical methods for the solution and discretization of the fundamental equations of fluid mechanics.
- know the mathematical principles of solving the systems of linear equations and are able to apply methods for accelerating CFD simulations.
- are able to assess the stability of numerical methods and estimate sources of error.
- are able to decide on the use of different models and procedures.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Applied Thermodynamics and Phase Behaviour of Hydrocarbons | Prof. Dr.-Ing. Philip Jaeger | W 6104 | V+Ü | 3 | 42 h / 108 h |

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| **2** | Advanced Fluid Properties | Prof. Jaeger | W 6164 | V+Ü | 2 | 28 h / 62 h |
| **3** | Numerical Fluid Mechanics | Prof. Nina Gunkelmann. | W 8035 | V+Ü | 3 | 42 h / 93 h |
| | | | | **Summe:** | 9 | 112 h / 263 h |

| **Zu Nr. 1:** | |
|---|---|
| **18a. Empf. Voraussetzungen** | Basical knowledge in thermodynamics and fluid properties |
| **19a. Inhalte** | • Fundamental laws of thermodynamics<br>• Phase behavior of ideal system, real systems and mixtures<br>• Mixtures containing carbon dioxide and hydrogen<br>• Multiphase systems, concept of miscibility<br>• Thermodynamics of interfaces<br>• PVT diagrams, calculations, simulations<br>• Minimum miscibility pressure<br>• Power cycles<br>• Gas hydrates |
| **20a. Medienformen** | Power point slides, videos, interactive multimedia |
| **21a. Literatur** | 1. Danesh, Ali: PVT and Phase Behaviour of Petroleum Reservoir Fluids. Developments in Petroleum Science 47, Elsevier Amsterdam 2008.<br>2. Gmehling, Jürgen, Kolbe, Bärbel: Thermodynamik, Georg Thieme Verlag Stuttgart, 1988 (Standardwerk).<br>3. Sloan, E. Dendy, Koh, Carolyn A.: Clathrate Hydrates of Natural Gases, CRC Press, Boca Raton 2008.<br>4. Stephan, Peter et al.: Thermodynamik, Springer-Verlag Heidelberg, 2009. |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | Basical knowledge in thermodynamics and fluid properties |
| **19b. Inhalte** | • Pure substances: fluid properties like density and viscosity - definitions, fundamentals and measurement methods)<br>• Mixtures: fluid properties like density and viscosity, solubility, pH, surface tension – definitions, fundamentals and measurement methods;<br>• Heat and mass transfer<br>• Dispersions<br>• Instrumentation |
| **20b. Medienformen** | • Power point slides, videos, interactive multimedia<br>• Practical demonstration of laboratory devices for the determination of physico-chemical fluid properties |

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| **21b. Literatur** | 1. Sattler, Klaus: Thermische Trennverfahren: Grundlagen, Auslegung, Apparate, 3. Auflage, Wiley-VCH, 2001 (Standardwerk).<br>2. Stephan, Peter et al.: Thermodynamik, Springer-Verlag Heidelberg, 2009.<br>3. Stephan, Peter: VDI-Wärmeatlas, 12. Auflage, Springer Verlag, Berlin, 2019.<br>4. Eggers, Rudolf: Industrial High Pressure Applications, Wiley-VCH, 2012.<br>5. Myers, Drew: Surfaces, Interfaces, and Colloids, NY: Wiley VCH, New York,2.ed., 1999. (Standardwerk) |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | Basics of mathematics, physics and fluid mechanics |
| **19c. Inhalte** | • Conservation equations of fluid mechanics, classification from a mathematical point of view, boundaries and initial conditions.<br>• Finite difference method, principles, accuracy assessment, application to solve a linear scalar transport equation in one and two dimensions.<br>• Solution of linear systems of equations, direct solvers (TDMA, LU decomposition), iterative solvers (incomplete LU), conjugate gradient methods.<br>• Finite volume method, principles, discretization of scalar convection-diffusion equations, common discretization procedures.<br>• Unsteady flows, explicit and implicit methods.<br>• Properties of iterative algorithms, stability, convergence, consistency (Lax's theorem), conservativity, boundedness.<br>• Computational methods for elliptic problems, possibilities of pressure-velocity coupling, SIMPLE method and variants.<br>• Options for simulation / modeling of turbulence, closure assumptions.<br>• 9. Grid generation (preprocessing), integration with other CA techniques, multigrid, parallel processing, and high-performance computing, visualization/postprocessing of numerical data. |
| **20c. Medienformen** | Blackboard, slides |
| **21c. Literatur** | 1. Script<br>2. J. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 1999.<br>3. C. Hirsch, Numerical computation of internal and external flow, Wiley, 1988. |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-Art | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **1** | Applied Thermodynamics and Phase Behaviour of Hydrocarbons | MP | 4 | graded | 40 % |
| **2** | Advanced Fluid Properties | MP | 3 | graded | 30 % |
| **3** | Numerical Fluid Mechanics | MP | 3 | graded | 30 % |

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| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Module examination. Up to 35 participants oral examination (30 minutes), otherwise written exams (60 minutes). At least 50% of maximal score number is required to pass the written exam. The contents of the exam is equally distributed from the courses weighted by the credit points. A minimum of 50% in each section is necessary to pass the exam. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Dr.-Ing. Philip Jaeger / Dipl.-Ing. Martina Szabries / Prof. Nina Gunkelmann. |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Group Project |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>12 | **8. Dauer**<br>[X] 1 Semester<br>[ ] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

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.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Group Project | Prof. Ganzer, Prof. Jaeger | W 6171 | Ü | 6 | 84 h / 276 h |
| | | | | **Summe:** | 6 | 84 h / 276 h |

**Zu Nr. 1:**

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| **18a. Empf. Voraussetzungen** | For the Reservoir Technologies area of study at least 44 CP to achieve in the Modules “Soft Skills”, “Reservoir Management and Law”, “Fluid Phase and Flow Behaviour”, “Reservoir Modeling” and Simulation” and “Lab and Measurements”.<br>For the Drilling and Production Technologies area of study at least 44 CP to achieve in the Modules “Soft Skills”, “Reservoir Management, Economics and Law”, “Fluid Phase and Flow Behaviour”, “Advanced Production and Processing” and “Drilling and Completion”.<br>Admission requirements must be completed. |

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| **19a. Inhalte** | 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 |
| **20a. Medienformen** | • 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. |
| **21a. Literatur** | 1. ITE Guidelines on the preparation of technical reports and principles of scientific writing.<br>2. Technical reports on the group project subjects supplied by the group project sponsors.<br>3. Special literature related to the group project issues should be collected from the open sources by the group project teams.<br>4. 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Group Project | MP | 12 | graded | 100 % |

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| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Group project report and 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ganzer, Prof. Jaeger |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Master Thesis |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 28 | [X] 1 Semester<br>[ ] 2 Semester | [X] jedes Semester<br>[ ] jedes Studienjahr<br>[ ] unregelmäßig |
| **10. Lern-/Qualifikationsziele des Moduls** | | | |
| 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. | | | |

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Master Thesis | Prof. Ganzer, Prof. Jaeger | | Ab | 16 | 40 h / 800 h |
| | | | | **Summe:** | 16 | 40 h / 800 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | More than 80 “LP” must be collected and all the admission requirements completed. |
| **19a. Inhalte** | 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 |
| **20a. Medienformen** | • 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 |

| | |
|---|---|
| **21a. Literatur** | Assessment of relevant literature sources should be carried out by the MSc candidate as part of the master thesis. |
| **22a. Sonstiges** | The MSc candidates are asked to set an appointment for the colloquium with the secretary office in advance. |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Master Thesis | MP | 28 | graded | 100 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ganzer / Prof. Jaeger |
| **31. Prüfungsvorleistungen** | None |

# Pflichtmodule der Studienrichtung „Reservoir Technologies“

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Reservoir Modeling and Simulation |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 10 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

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.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Geological Modeling | Prof. Ganzer | W 4820 | V+Ü | 2 | 28 h / 62 h |
| **2** | Fundamentals of Reservoir Simulation | Prof. Ganzer | S 6102 | V | 2 | 28 h / 62 h |
| **3** | Reservoir Simulation Workshop | Prof. Ganzer | S 6165 | Ü | 3 | 42 h / 92 h |
| | | | | **Summe:** | 7 | 56 h / 216 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites |
|---|---|

| | |
|---|---|
| **19a. Inhalte** | 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>b) Practical part: Introduction to Petrel software package (well correlation, static geological model) |
| **20a. Medienformen** | • 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>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **21a. Literatur** | 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. |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | Theory of:<br>• History and classification of reservoir simulators<br>• Review of fluid properties for simulation<br>• Rock properties and saturation functions<br>• Upgridding and upscaling<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>• Equilibration and initialization of reservoir simulation models |

| | |
|---|---|
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21b. Literatur** | 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. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | No special prerequisites |
| **19c. Inhalte** | • Grid building, initialization and simulation in black oil mode<br>• Tutorial of the used commercial software |
| **20c. Medienformen** | • Multimedia lecturing tools<br>• Software demo (software based walk through)<br>• Computer aided exercises using the application of the commercial reservoir modeling software and Matlab |
| **21c. Literatur** | 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. |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Geological Modeling | MP | 3 | graded | 30 % |
| **2** | Fundamentals of Reservoir Simulation | MP | 4 | graded | 40 % |
| **3** | Reservoir Simulation Workshop | MP | 3 | graded | 30 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Continuous assessment and report, Project work, Modul examination. Written (90 -120 min) or oral exam (20-60 min). The mark of the three courses consists of a) theoretical part -> final exam (written) and b) practical part -> continuous assessment and report. The contents of the exam is equally distributed from the courses weighted by the credit points.<br>A minimum of 50% is necessary to pass the exam. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ganzer |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Lab and Measurements |

**2. Verwendbarkeit des Moduls in Studiengängen**

M.Sc. Petroleum Engineering

| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
|---|---|---|---|
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 6 | [X] 1 Semester<br>[ ] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Applied Well Test Analysis:

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.

Laboratory Measurement Techniques:

Core analysis is subdivided into two categories: conventional routine core analysis and special core analysis (SCAL). Although, here, the main focus is given to SCAL, routine core analysis is valuable to understand the basics of the procedure. Routine core analysis allows the students to learn, hand-in-hand, the sources of laboratory porosity, permeability and saturation measurements. SCAL, on another side, involves more experiments to extend the data, such as capillary pressure, relative permeability and wettability. These data can then be used to support log and well test data and to gain a clearer picture on overall reservoir performance.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Applied Well Test Analysis | Prof. Ostrowski | S 6109 | V+Ü | 2 | 28 h / 62 h |
| **2** | Laboratory Measurement Techniques | Dr.Jenei | W 6139 | V+Ü | 2 | 28 h / 62 h |
| | | | | **Summe:** | 4 | 56 h / 124 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | No special prerequisites |
| **19a. Inhalte** | • 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. |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21a. Literatur** | 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • Fundamentals of core-flooding and microfluidic analysis<br>• Core-flooding experiments, such as RCA (routine core analysis) and SCAL (special core analysis)<br>• Analytical and numerical interpretation of the laboratory measurements<br>• Microfluidic experiments (microchip based microscale measurements)<br>• Image segmentation analysis of the microfluidic measurements |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• Lab demo (core-flooding, microfluidic measurements)<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory (optionally) |

| | |
|---|---|
| **21b. Literatur** | 1. Lenormand, R., Lorentzen, K., Maas, J. G., and Ruth, D. (2016). Comparison of four Numerical Simulators for SCAL Experiments. International Symposium of the Society of Core Analysts, 21-26 August 2016, Colorado, USA. SCA2016-006.<br>2. Loeve, D. W. (2011). Simultaneous determination of relative permeability and capillary pressure curves by assisted history matching several SCAL experiments. SCA2011-3. International Symposium of the Society of Core Analysts, 18-21 September 2011, Austin, Texas, USA.<br>3. Brooks, R. H. and Corey, A.T. (1964). Hydraulic properties of porous media. Hydrology Paper, Vol. 3, Colorado State University, Fort Colins. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Applied Well Test Analysis | MTP | 3 | graded | 50 % |
| **2** | Laboratory Measurement Technologies | MTP | 3 | graded | 50 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Partial examinations. Written (90 -120 min) or oral exam (20-60 min). At least 50% of maximal score number is required to pass the written exam. The module grade is evaluated as average grade from the partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ostrowski, Prof. Ganzer |
| **31. Prüfungsvorleistungen** | None |

| 1a. Modultitel (deutsch) | 1b. Modultitel (englisch) |
|---|---|
| | Seminar |

| 2. Verwendbarkeit des Moduls in Studiengängen | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Ganzer | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>6 | **8. Dauer**<br>[X] 1 Semester<br>[ ] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |
| **10. Lern-/Qualifikationsziele des Moduls**<br>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 | | | |

**Lehrveranstaltungen**

| 11. Nr. | 12. Lehrveranstaltungstitel (deutsch/englisch) | 13. Dozent(in) | 14. LV-Nr. | 15. LV-Art | 16. SWS | 17. Arbeitsaufwand Präsenz-/Eigenstudium |
|---|---|---|---|---|---|---|
| 1 | Reservoir Research Project | Prof. Ganzer | S 6161 | S | 4 | 56 h / 124 h |
| | | | | **Summe:** | 4 | 56 h / 124 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | Only the candidates achieved at least 27 CP in the modules “Soft Skills”, “Fluid Phase and Flow Behaviour”, “Reservoir Modeling” and Simulation” “Lab and Measurements” and compulsory elective modules are qualified to attend at the Master seminar.<br>The consecutive E+R and Geo-Energy Systems bachelor students enrolled into the Master PE must have passed the Bachelor seminar to be eligible to attend at the Master seminar. |
| **19a. Inhalte** | Students work on assigned special topics, report and present results obtained via individual efforts within of a regular time of 6-7 weeks. |
| **20a. Medienformen** | • DIN A3 Poster to be posted at a pin-board<br>• MS PowerPoint presentation<br>• White board |
| **21a. Literatur** | The supervisor should provide key literature sources. Assessment of further relevant literature sources should be carried out by the candidate as part of seminar study |

| | |
|---|---|
| **22a. Sonstiges** | Participants are requested to register for the attendance with the seminar directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Reservoir Research Project | MP | 6 | graded | 100 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ganzer |
| **31. Prüfungsvorleistungen** | None |

# Pflichtmodule der Studienrichtung „Drilling and Production Technologies“

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Advanced Production and Processing |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>8 | **8. Dauer**<br>[ ] 1 Semester<br>[X] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Advanced Production:

Acquisition of profound knowledge in hydrocarbon production engineering, necessary to develop the ability of applying it in the practice with the main goal of optimizing and reaching the maximum hydrocarbon recovery in the most efficient and economical way. After the course, the students will be able to theoretically understand and to practically handle sub-surface and surface petroleum production systems.

Advanced Hydrocarbon Conditioning and Processing:

Acquisition of knowledge of techniques and design requirements for the conditioning & processing of oil & gas.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Advanced Production (including EP) | Dr.-Ing. Perozo Baptista | W 6131 | V+Ü | 3 | 42 h / 108 h |
| **2** | Advanced Hydrocarbon Conditioning and Processing | Prof. Jaeger | S 6110 | V | 2 | 28 h / 62 h |
| | | | | **Summe:** | 5 | 70 h / 170 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | No special prerequisites |
| **19a. Inhalte** | • Introduction to integrated production systems<br>• Review of reservoir inflow characterization in vertical and horizontal wells, inflow dynamics and modeling tools<br>• Review of multiphase flow modeling in wellbores, risers and flowlines.<br>• Flow patterns in wellbores<br>• Nodal Analysis and production optimization techniques<br>• Surface facilities<br>• Gradient models for compressible and multiphase flow<br>• Artificial lift techniques<br>• Linking the reservoir, the near-wellbore, the wellbore and the surface facilities<br>• Software implementation for production forecasting and optimization |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Computer aided exercises by using professional software |
| **21a. Literatur** | 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. |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • Fundamentals of Oil & Gas Processing<br>• Phase separation<br>• Dehydration principles<br>• Sour gas processing<br>• Process design (Absorption columns)<br>• Heat transfer and heat exchanger design<br>• Gas hydrate formation<br>• Pumps, Compressors & Diverters<br>• Refrigeration Systems in Gas Processing<br>• Operation of Surface Facilities<br>• Challenges and Maintenance of Surface Facilities<br>• Safety, Environment and Human Factors in Design and Operations |

| | |
|---|---|
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Computer aided exercises by using professional software |
| **21b. Literatur** | 1. A. Danesh: PVT and Phase Behaviour of Petroleum Reservoir Fluids. Developments in Petroleum Science 47, Elsevier Amsterdam 2008<br>2. H. Devold: Oil and Gas Production Handbook, Edition 3.0 Oslo, 2013.<br>3. Economides, M.J., Hill, A.D. and Ehlig-Economides, C.: Petroleum Production Systems. Prentice Hall Petroleum Engineering Series, 2012.<br>4. J.M. Campbell: Gas Conditioning and Processing Vol. 2, Oklahoma, 1998<br>5. 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. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Advanced Production (including EP) | MP | 5 | graded | 62,5 % |
| 2 | Advanced HC conditioning and Processing | MP | 3 | graded | 37,5 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Module examination. Written (90 -120 min) or oral exam (20-60 min) for each discipline. At least 50% of maximal score is required to pass the written exam. The contents of the exam is equally distributed from both courses weighted by the credit points.<br>A minimum of 50% in each section is necessary to pass the exam. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Philip Jaeger, Dr.-Ing. Perozo |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Drilling and Completion |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>8 | **8. Dauer**<br>[X] 1 Semester<br>[ ] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Completion and Workover

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. 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

Directional Drilling

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

Knowledge of logging methods in cased holes and interpretation

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Completion and Workover | Prof. Teodoriu | S 6121 | V+Ü | 3 | 42 h / 108 h |
| **2** | Directional Drilling | Prof. Oppelt | S 6125 | V | 2 | 28 h / 92 h |
| | | | | **Summe:** | 5 | 70 h / 200 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites |
|---|---|

| | |
|---|---|
| **19a. Inhalte** | • 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 |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21a. Literatur** | 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • 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 |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |

| | |
|---|---|
| **21b. Literatur** | 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 laterVieira, J. L., Controlled Directional Drilling, Petex, The University of Texas at Austin, 4th edition, 2009Mitchell, R.F., Miska, S., Fundamentals of Drilling Engineering, SPE Textbook Series, Vol.12, 2011.<br>4. Reinicke, K., Hueni, G., Liermann, N., Oppelt, J., Reichetseder, P., Unverhaun, W., Ullmann's Encyclopedia of Industrial Chemistry, Oil & Gas, John Wiley & Sons, Inc., March 2014, published online, and print version (Ullmann's Energy: Resources, Processes, Products, 3 Volume Set, Wiley-VCH (Editor), ISBN: 978-3-527-33370-7, 1479 pages, April 2015.<br>5. Azar, J.J., Samuel, G.R., Drilling Engineering, PennWell Corp., March 2007. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Completion and Workover | MTP | 5 | graded | 62,5 % |
| 2 | Directional Drilling | MTP | 3 | graded | 37,5 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Partial examinations. Written (90 -120 min) or oral exam (20-60 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 partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Teodoriu / Dr. Paz Carvajal / Prof. Oppelt |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Seminar |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>6 | **8. Dauer**<br>[X] 1 Semester<br>[ ] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |
| **10. Lern-/Qualifikationsziele des Moduls**<br>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 | | | |

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Drilling and Production Research Project | Prof. Jaeger | S 6162 | S | 4 | 56 h / 124 h |
| | | | | **Summe:** | 4 | 56 h / 124 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | Only the candidates achieved at least 27 CP in the modules “Soft Skills”, “Fluid Phase and Flow Behaviour”, “Advanced Production and Processing”, “Drilling and Completion” and compulsory elective modules are qualified to attend at the Master seminar.<br>The consecutive E+R and Geo-Energy Systems bachelor students enrolled into the Master PE must have passed the Bachelor seminar to be eligible to attend at the Master seminar. |
| **19a. Inhalte** | Students work on assigned special topics, report and present results obtained via individual efforts within of a regular time of 6-7 weeks. |
| **20a. Medienformen** | • DIN A3 Poster to be posted at a pin-board<br>• MS PowerPoint presentation<br>• White board |
| **21a. Literatur** | 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. |

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|---|---|
| **22a. Sonstiges** | Participants are requested to register for the attendance with the seminar directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Drilling and Production Research Project | MP | 6 | graded | 100 % |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Jaeger |
| **31. Prüfungsvorleistungen** | None |

# Wahlpflichtmodule des Wahlpflichtmodulkatalogs A „Reservoir Technologies“

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Reservoir Engineering |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Ganzer | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>12 | **8. Dauer**<br>[ ] 1 Semester<br>[X] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Equation of State Fluid Characterisation
The objective of this course is to introduce the students into the topic of fluid phase behaviour with focus on black-oil formulations for oil and gas reservoirs. During the initial part, the focus will be on classical fluid properties as defined for black-oil fluid types and hydrocarbon gases. The second part will cover fluid sampling, PVT laboratory experiments and PVT report analysis for further use in reservoir engineering.
Enhanced Oil Recovery:
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 behaviour of hydrocarbons will be consolidated and established on an advanced level
Underground Storage of Energy and Gases:
Knowledge about different types of gas storages and their characteristics. Basic instruments for design, development and operation of underground gas storages. General knowledge about physical, thermodynamic and microbiological aspects during subsurface storage of gases (natural gas, CH4, H2, CO2, air). Principles of energy storage concepts in a renewable energy supply system.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Equation of State Fluid Characterisation | Prof. Ganzer | W 6156 | V+Ü | 3 | 42 h / 62 h |
| **2** | Enhanced Oil Recovery | Prof. Ganzer | W 6103 | V | 2 | 28 h / 62 h |

| | | | | | | |
|---|---|---|---|---|---|---|
| **3** | Underground Storage of Energy and Gases | Dr. Hagemann | S 6113 | V+Ü | 2 | 28 h / 62 h |
| | | | | **Summe:** | 7 | 98 h / 186 h |

| | |
|---|---|
| **Zu Nr. 1:** | |
| **18a. Empf. Voraussetzungen** | No special prerequisites |
| **19a. Inhalte** | Hydrocarbon phase behavior during the reservoir life-cycle. Black-oil properties in detail with respect to modelling. Laboratory work and experiments (CCE, DLE, Separator Test, etc.). Real-world PVT laboratory reports, QC and interpretation of PVT reports.<br>• Basic PVT and Black-Oil:<br>- Principal fluid phase behavior<br>- PVT behavior of natural gases<br>- Black-oil PVT properties<br>- Water in hydrocarbon system<br>• PVT Experiments and EOS:<br>- Introduction to cubic Equations of State (EOS)<br>- Compositional vs. Black-oil PVT modelling<br>- Fluid sampling and PVT experiments<br>- Understanding of PVT reports and generation of black-oil tables |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21a. Literatur** | 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • Basics of Waterflooding;<br>• Chemical Flooding;<br>• Gas Flooding;<br>• Steam Flooding;<br>• Well Treatment |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |

| | |
|---|---|
| **21b. Literatur** | 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). |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | No special prerequisites (BSc Energie und Rohstoffe with the specialization in Petroleum Engineering) |
| **19c. Inhalte** | Motivation for gas storage, types of underground gas storages, components of gas storage facilities, history of gas storage, overview of gas storages in Germany and worldwide, terms and definitions (working gas, cushion gas, inventory, capacity, deliverability,...), properties and thermodynamics of gases (natural gas, CH4, H2, CO2, air), properties of storage rocks and cap rocks, gas storage in porous media, gas storage in caverns, underground hydrogen storage, underground bio-methanation, CO2 storage, compressed air energy storage |
| **20c. Medienformen** | • Slides + Exercises |
| **21c. Literatur** | 1. Flanigan, Orin: Underground gas storage facilities: Design and implementation. Elsevier, 1995.<br>2. Tek, Mehmet Rasin:Underground storage of natural gas: theory and practice. Vol. 171. Springer Science & Business Media, 2012.<br>3. Tek, Mehmet Rasin: Natural gas underground storage: inventory and deliverability. Pennwell Corporation, 1996.<br>4. Tek, Mehmet Rasin: Underground storage of natural gas, complete design and operational procedures. 1987.<br>5. Katz, Donald La Verne, and Keith Hal Coats: Underground storage of fluids. Ulrich's Books, 1968. |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Equation of State Fluid Characterisation | MTP | 4 | graded | 1/3 |
| **2** | Enhanced Oil Recovery | MTP | 4 | graded | 1/3 |
| **3** | Underground Storage of Energy and Gases | MTP | 4 | graded | 1/3 |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Homework Assignments, Reports and presentation. / Partial examinations. Written (90 -120 min) or oral exam (20-60 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 points. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Ganzer, Dr. Hagemann |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Advanced Reservoir Modeling |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Ganzer | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>12 | **8. Dauer**<br>[ ] 1 Semester<br>[X] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Reservoir Model Validation:
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.

Advanced Rock Physics:
Acquisition of advanced knowledge in the evaluation of physical properties of reservoir rocks/
Ability to understand and to apply the advanced techniques of reservoir rock characterization

Advanced Geostatistics:
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.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Reservoir Model Validation | Dr. Schulze-Riegert | S 6103 | V | 2 | 28 h / 78 h |
| **2** | Advanced Rock Physics | Dr. Wegner | W 6118 | V + Ü | 2 | 28 h / 92 h |
| **3** | Advanced Geostatistics | Dr. Shäfer | W 4635 | V + Ü | 3 | 42 h / 108 h |
| | | | | **Summe:** | 7 | 98 h / 278 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites |
|---|---|

| | |
|---|---|
| **19a. Inhalte** | • 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. |
| **20a. Medienformen** | • 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>• A soft pdf copy of PowerPoint presentation slides to be provided on the Stud.IP directory of the course. |
| **21a. Literatur** | 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |

| | |
|---|---|
| **19b. Inhalte** | • 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>Exercises:<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 |
| **20b. Medienformen** | • Multimedia lecturing tools<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 |
| **21b. Literatur** | Authentic lecturing and training materials, Handouts |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | No special prerequisites |
| **19c. Inhalte** | • 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 |
| **20c. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |

| | |
|---|---|
| **21c. Literatur** | Literature recommendations are available with the lecture notes |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Reservoir Model Validation | MTP | 4 | graded | 1/3 |
| **2** | Advanced Rock Physics | MTP | 4 | graded | 1/3 |
| **3** | Advanced Geostatistics | MTP | 4 | graded | 1/3 |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Partial examinations. Written (90 -120 min) or oral exam (20-60 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. |
| **30. Verantwortliche(r) Prüfer(in)** | Dr. Schulze-Riegert, Dr. Wegner, Dr. Mueller |
| **31. Prüfungsvorleistungen** | None |

# Wahlpflichtmodule des Wahlpflichtmodulkatalogs B „Drilling and Production Technologies“

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Drilling and Production Engineering |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)**<br>Prof. Jaeger | | **4. Zuständige Fakultät**<br>Fakultät für Energie- und Wirtschaftswissenschaften | **5. Modulnummer** |
| **6. Sprache**<br>Englisch | **7. LP**<br>12 | **8. Dauer**<br>[ ] 1 Semester<br>[X] 2 Semester | **9. Angebot**<br>[ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Rock Mechanics in Subsurface Energy Systems:
Ability to apply mathematical methods to describe mechanical behaviour of reservoir rocks for solution of reservoir engineering problems should be developed. Students will become capable to acquire and evaluate physical properties of reservoir rocks needed for reservoir characterization and simulation and will develop a professional expertise in the application methods for solution of real reservoir engineering problems.
Materials Engineering and Corrosion:
Ability to employ appropriate materials and to design petroleum equipment and facilities.
Well Planning:
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.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Rock Mechanics in Subsurface Energy Systems | Prof. Hou | W 6234 | V+Ü | 3 | 42 h / 108 h |
| **2** | Materials Engineering and Corrosion | Prof. Jaeger | S 6117 | V | 2 | 28 h / 62 h |
| **3** | Well Planning | Dr. Schamp | W 6105 | V+Ü | 3 | 42 h / 108 h |
| | | | | **Summe:** | 8 | 112 h / 278 h |

| **Zu Nr. 1:** | |
|---|---|
| **18a. Empf. Voraussetzungen** | No special prerequisites |
| **19a. Inhalte** | • Poroelastic theory<br>• Borehole stability<br>• Sand production prediction<br>• Reservoir engineering applications |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21a. Literatur** | 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. |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • 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 |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory |

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|---|---|
| **21b. Literatur** | Authentic lecturing materials and handouts |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • Fundamentals of Well Planning<br>• Trajectory Planning<br>• Casing and Drillstring Design<br>• Cementing<br>• BOP<br>• Examples and Case Studies |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21b. Literatur** | 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 |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| 1 | Rock Mechanics in Subsurface Energy Systems | MTP | 4 | graded | 1/3 |
| 2 | Materials Engineering and Corrosion | MTP | 4 | graded | 1/3 |
| 3 | Well Planning | MTP | 4 | graded | 1/3 |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Homework, Assignments, Reports and presentation. Partial examinations. Written (90 -120 min) or oral exam (20-60 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.partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Hou, Prof. Jaeger, Dr. Schamp |

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|---|---|
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Digital Drilling and Monitoring |

**2. Verwendbarkeit des Moduls in Studiengängen**

M.Sc. Petroleum Engineering

| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
|---|---|---|---|
| Prof. Jaeger | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 12 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Advanced Drilling Technology:

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.

Digital Drilling Lab:

Students

-are able to set up and conduct a drilling project with a small-scale drilling test stand.

-know and understand drilling principles, interaction of drilling system components.

-know and understand sensor and actuator technology on drilling rigs, programmable logical controllers.

-apply mathematical methods for drilling hydraulics/ mechanics, interpret and analyze drilling data; apply the mechanical specific energy model to the drilling process.

-optimize the drilling process; adjust drilling variables.

Digital Transformation in Oil and Gas:

Acquire technical skills on digital and data driven technologies and techniques used for the optimization of the drilling activities. Acquire technical skills about automation tools and automated processes. Design and implement digital twins for optimizing system performance. Acquire basic programming competences (Matlab/Python).

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Advanced Drilling Technology | Dr. Prohaska | W 6122 | V + Ü | 3 | 42 h / 108 h |
| **2** | Digital Drilling Lab | MSc. Feldmann | S 6185 | V + Ü | 3 | 42 h / 92 h |
| **3** | Digital Transformation in O&G | Dr. Paz Carvajal | W 6186 | V + Ü | 3 | 42 h / 92 h |

| | | |
|---|---|---|
| **Summe:** | 9 | 126 h / 192 h |
| **Zu Nr. 1:** | | |
| **18a. Empf. Voraussetzungen** | No special prerequisites | |
| **19a. Inhalte** | • Well integrity<br>• BHA design<br>• Casing design<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>• Blow out<br>• Case studies | |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 | |
| **21a. Literatur** | 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. | |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP | |
| **Zu Nr. 2:** | | |
| **18b. Empf. Voraussetzungen** | Basics of drilling technology and processes, automation, fluid mechanics, software design | |

| | |
|---|---|
| **19b. Inhalte** | The students are to conduct supervised project work in the Digital Drilling Lab. The project work includes the independent interdisciplinary planning of small scale drilling experiments; the processing and interpretation of derived drilling data and the implementation of drilling optimization methods and techniques. The students issue written reports and present their work at the end of the semester in form a written theoretical work and presentation. |
| **20b. Medienformen** | Blackboard, slides, Digital Drilling Lab |
| **21b. Literatur** | 1. R. Mitchell, S. Miska, Fundamentals of Drilling Engineering, 2011<br>2. Dupriest, F. E. and Koederitz, W. L. (2005). Maximizing Drill Rates with Real-Time Surveillance of<br>3. 249 Mechanical Specific Energy. In SPE-92194-MS, page 10, SPE. Society of Petroleum Engineers.<br>4. Armenta, M. (2008). Identifying Inefficient Drilling Conditions Using Drilling-Specific Energy. In SPE-234 116667-MS, page 16, SPE. Society of Petroleum Engineers. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | Subjects included are:<br>• Introduction to cyber-physics models<br>• Introduction to modeling software.<br>• Introduction to data processing methods.<br>• Prototyping.<br>• Real time testing.<br>• Robotics and autonomous systems |
| **20b. Medienformen** | • Multimedia lecturing tools.<br>• PowerPoint presentation software and white board.<br>• Soft pdf copy of PowerPoint presentation available on demand within the Stud.IP. |
| **21b. Literatur** | 1. Bangert, Patrick: “Machine Learning and Data Science in the Oil and Gas Industry: Best Practices, Tools, and Case Studies”. Gulf Professional Publishing. 2021<br>2. Samuel, Robello / Azar, J.J. / Aideyan Prosper: “Applied Drilling Engineering Optimization”. Sigmaquadrant. 2017<br>3. Lie Hetland, Magnus: “Python Algorithms: Mastering Basic Algorithms in Python Language”, Apress, 2010<br>4. Related papers and articles provided over the Stud.IP |

| | |
|---|---|
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP<br>Required software applications provided or addressed during the course. |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Advanced Drilling Technology | MTP | 4 | graded | 1/3 |
| **2** | Digital Drilling Lab | MTP | 4 | graded | 1/3 |
| **3** | Digital Transformation in Oil &Gas | MTP | 4 | graded | 1/3 |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Advanced Drilling Technology<br>Homework assignments and project work including report and presentation are evaluated part of the overall course performance. Partial examination. Written (90 – 120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam. The overall course grade is evaluated as weighted average affected by 50% exam grade, 30 % project work grade and 20 % homework grade.<br>Digital Drilling Lab:<br>Partial examination. Written (90 – 120 min) or oral exam (20-60 min). At least 50% of maximal score is required to pass the written exam.<br>Digital Transformation in Oil and Gas:<br>Online assignments, homework/ In-class participation and written exam (90 min). At least 50% of maximal score number is required to pass the written exam.<br>The module grade is evaluated as average grade from the partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Dr. Prohaska / Dr. Feldmann / Dr. Paz Carvajal |
| **31. Prüfungsvorleistungen** | None |

# Wahlpflichtmodule des Wahlpflichtmodulkatalogs C „Interdisciplinary“

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Geosciences |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 12 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Petrophysics I:
Knowledge of geophysical rock properties and their application to the characterization of reservoirs.
Applied Seismic Data Interpretation:
Geophysical theory of reflection seismic, seismic acquisition techniques, pitfalls in depth conversion, practical interpretation of seismic data (2D), seismic attribute extraction, making maps from seismic interpretation. Ability to understand and apply the advanced techniques of seismic data acquisition and interpretation
Well Logging II:
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.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Petrophysics I | Dr. Breede | W 4021 | V + Ü | 3 | 42 h / 108 h |
| **2** | Applied Seismic Data Interpretation | Dr. Li | S 4008 | V + Ü | 3 | 42 h / 78 h |
| **3** | Well Logging II | Dr. Li | S 4023 | V + Ü | 3 | 42 h / 108 h |
| | | | | **Summe:** | 9 | 126 h / 294 h |

**Zu Nr. 1:**

| | |
|---|---|
| **18a. Empf. Voraussetzungen** | No special prerequisites |
| **19a. Inhalte** | 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 |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory<br>• Computer aided exercises by using professional software |
| **21a. Literatur** | 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 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |

| | |
|---|---|
| **19b. Inhalte** | • Geophysical Fundamentals: Harmonic Oszillations, Waves, Basics of Reflection Seismic, Impedance Contrast, the Meaning of a Seismic Reflector, Reflection Geometry, Ray-path Models, Frequency-dependent Seismic Resolution, Domain Conversion (Time to Depth, Depth to Time), Seismic Acquisition Systems onshore/offshore , 2D Seismic, 3D Seismic (reflection). Refraction Seismic, surface Wave Methods, Vertical seismc profiling (VSP), Sub-Surface (Full Space) Seismic.<br>• Structural Seismic Interpretation: where to pick a seismic reflector, automated seismic interpretation (autotracking), Amplitude vesus Offset (AVO), interpretation of faults. Optional: generating seismic attributes from surfaces and seismic volumes.<br>• Introduction to Seismic Sequence Interpretation: Meaning of Depositional Sequences, Deposition and Erosion (Basic Geology), Seismic Facies Characterization, the Meaning of Seismic Reflector Terminations and Sequence Boundaries (onlap, downlap, etc.) |
| **20b. Medienformen** | The lecture is accompanied by practical exercises on real 2D seismic data sets using a data processing software (knowledge in using the software is no pre-requisite). Depending on your progess, using the data in OpenSource interpretation software will be added. |
| **21b. Literatur** | The recommended literature is available with the lecture notes |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |
| **19b. Inhalte** | • Introduction<br>• Radiometric methods<br>• Acoustic methods<br>• Electrical methods |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<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 |
| **21b. Literatur** | 1. Ellis, D.E.: Well Logging for Earth Scientists, Elsevier, 1987<br>2. Fricke, S.; Schön, J.: Praktische Bohrlochgeophysik, Enke, 1999 |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Petrophysics I | MTP | 4 | graded | 1/3 |
| **2** | Applied Seismic Data Interpretation | MTP | 4 | graded | 1/3 |
| **3** | Well Logging II | MTP | 4 | graded | 1/3 |

| | |
|---|---|
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Partial examinations. Written (90 -120 min) or oral exam (20-60 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 partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Dr. Breede, Dr. Li |
| **31. Prüfungsvorleistungen** | None |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Geothermal Systems |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
| Prof. Jaeger | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 12 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Geothermal Geology:
A profound understanding of the different types of geothermal resources, how they can be found and in which geological settings.
Enhanced Geothermal Systems and Geothermal Production Systems:
Acquisition of knowledge of geothermal reservoir characterisation in terms geothermal potential. Acquisition of theoretical and practical fundamentals for reservoir modelling. Geothermal fluid system properties. Theoretical and practical understanding of geothermal production systems. Acquisition of knowledge of the different uses of geothermal energy: power generation, heat pumps and direct heating, combined heat and power.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Geothermal Geology | Dr. Meneses Rioseco | W 4660 | V+Ü | 2 | 28 h / 62 h |
| **2** | Enhanced Geothermal Systems | Prof. Jaeger | S 6149 | V | 2 | 28 h / 78 h |
| **3** | Geothermal Energy Production Systems | Prof. Jaeger | W 6150 | V | 2 | 28 h / 78 h |
| | | | | **Summe:** | 6 | 84 h / 218 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites |
|---|---|

| | |
|---|---|
| **19a. Inhalte** | • 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). |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory |
| **21a. Literatur** | 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/ |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | Basic knowledge in Geology, Thermodynamics and Heat Transfer |
| **19b. Inhalte** | • 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>• Modelling of temperature profiles<br>• Well Stimulation and engineered geothermal systems |
| **20b. Medienformen** | • Multimedia lecture tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Practical lab exercises on thermal properties (heat conductivity)<br>• Modelling of phase behaviour under reservoir conditions |

| | |
|---|---|
| **21b. Literatur** | 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. Nicholson, K. (1993): Geothermal Fluids, Springer Verlag<br>6. Dake, L.P. (1978): Fundamentals of Reservoir Engineering. Elsevier |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | Basic knowledge in Geology, Thermodynamics and Heat Transfer |
| **19c. Inhalte** | • 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. |
| **20c. Medienformen** | • Multimedia lecture tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation available with the Stud.IP course directory<br>• Practical lab exercises on fluid properties<br>• Modelling exercises on heat transfer |
| **21c. Literatur** | 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 |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
|---|---|---|---|---|---|
| **1** | Geothermal Geology | MP | 4 | graded | 1/3 |
| **2** | Enhanced Geothermal Systems | MP | 4 | graded | 1/3 |

| | | | | | |
|---|---|---|---|---|---|
| **3** | Geothermal Energy Production Systems | MP | 4 | graded | 1/3 |
| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Module examination. Written (90 -120 min) or oral exam (20-60 min) for each discipline. At least 50% of maximal score number is required to pass the written exam.<br>The contents of the exam is equally distributed from the courses weighted by the credit points. A minimum of 50% in each section is necessary to pass the exam. | | | | |
| **30. Verantwortliche(r) Prüfer(in)** | Dr. Meneses Rioseco, Prof. Jaeger | | | | |
| **31. Prüfungsvorleistungen** | None | | | | |

| **1a. Modultitel (deutsch)** | **1b. Modultitel (englisch)** |
|---|---|
| | Complex Fluid Systems |

| **2. Verwendbarkeit des Moduls in Studiengängen** | | | |
|---|---|---|---|
| M.Sc. Petroleum Engineering | | | |
| **3. Modulverantwortliche(r)** | | **4. Zuständige Fakultät** | **5. Modulnummer** |
| Prof. Ganzer | | Fakultät für Energie- und Wirtschaftswissenschaften | |
| **6. Sprache** | **7. LP** | **8. Dauer** | **9. Angebot** |
| Englisch | 12 | [ ] 1 Semester<br>[X] 2 Semester | [ ] jedes Semester<br>[X] jedes Studienjahr<br>[ ] unregelmäßig |

**10. Lern-/Qualifikationsziele des Moduls**

Complex Fluids-Flow and Transport Processes in Porous Media:
Complex fluids are often utilized for applications in EOR. They present two key challenges: how a small fraction of interacting particles conspire to dominate their flow properties, and how those properties influence particular flows. The goal of this course is to introduce students to the exciting (and pertinent) phenomena observed in complex fluids under flow. This combined with its relation to EOR field processes application.

**Lehrveranstaltungen**

| **11. Nr.** | **12. Lehrveranstaltungstitel (deutsch/englisch)** | **13. Dozent(in)** | **14. LV-Nr.** | **15. LV-Art** | **16. SWS** | **17. Arbeitsaufwand Präsenz-/Eigenstudium** |
|---|---|---|---|---|---|---|
| **1** | Applied Rheology | Dipl.-Ing. Martina Szabries | W 6126 | V + Ü | 3 | 42 h / 78 h |
| **2** | Complex Fluids-Flow and Transport Processes in Porous Media | Dr. Hincapie | S 6129 | V | 2 | 28 h / 64 h |
| **3** | Advanced Reservoir Simulation with Complex Fluids | Prof. Ganzer | W 6128 | V + Ü | 3 | 42 h / 78 h |
| | | | | **Summe:** | 8 | 112 h / 220 h |

**Zu Nr. 1:**

| **18a. Empf. Voraussetzungen** | No special prerequisites |
|---|---|

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| **19a. Inhalte** | • General introduction to rheology (Definitions, Derivation of viscous flow, Different types of viscosity/viscous flow (elongational, couette flow etc.), Special phenomena related to viscosity, Viscoelasticity: Elastic and viscous modulus, Temperature, pressure and time dependence, Solids, liquids (Newtonian and Non-Newtonian), gases, supercritical fluids, Rheology of dispersions (foams, emulsions, suspensions))<br>• Measurement techniques (Marsh funnel (mud test), Moving parts (e.g. falling/rolling ball) viscometer, Capillary viscometer, Rotational rheometer (different geometries), Oscillating rheometer, Measurement of gas-liquid mixtures)<br>• Surface rheology (Interfaces and adsorption at fluid interfaces, Marangoni convection and Gibbs elasticity, Shear and dilatation, Viscoelastic modules, parallels to volume rheology, Examples: reservoir fluids; surfactant solutions, Measurement techniques (oscillating drop, Langmuir trough))<br>• The rheological behaviour of fluids in a porous medium (Fluid flow and shear in a porous medium, Rheology of reservoir fluids (Crude oil, asphaltenes, gases, brine,...), Critical parameters for oil production (Mobility ratio), Rheology of IOR and EOR fluids (f.e. Polymers))<br>• Practical exercises |
| **20a. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory (optionally) |
| **21a. Literatur** | 1. T.G. Mezger: The Rheology Handbook, Vincentz Network, 2020<br>2. J. Sheng: Modern Chemical Enhanced Oil Recovery, Gulf Professional Publishing, 2010. Chapter 1, 4 and 6.<br>3. D. Myers: Surfaces, interfaces, and colloids, Wiley-VCH, 1999<br>4. H.A. Barnes, J.F. Hutton, K. Waters: An Introduction to Rheology, Rheology Series 3, Elsevier, 1989 |
| **22a. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 2:** | |
| **18b. Empf. Voraussetzungen** | No special prerequisites |

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| **19b. Inhalte** | Complex fluids, such as polymer solutions and dispersions, are frequently injected for well conformance and as an enhanced oil recovery method. The research being developed in this area is focused on understanding the fundamentals of flow of complex liquids, such as viscoelastic polymer solutions, oil-water emulsions and suspension of flexible microcapsules, in porous media and their application as EOR agent. The lecture includes but not limited to:<br>• Identification of the basic forces that give rise to complex fluid behavior: Complex fluids: oil / water / CO2 / colloids / polymers / surfactants<br>• Formulation and Non-Newtonian rheology. Dynamic properties (e.g. rheology) and microstructure. Interpretation of rheological results.<br>• State of the art techniques for characterization of complex fluid structure.<br>• Complex fluids and structure length scales in polymeric and colloidal systems. Molecular level explanation of macroscopic behaviour<br>• Pore-scale multiphase flow and reactive transport<br>• Core-flooding experiments, pore-scale flow visualization capillary network model and continuous model to understand complex flows<br>• Viscoelastic polymer solutions used for EOR<br>• Modelling of viscoelasticity and its effects in polymer flooding application<br>• Emulsion injection for increasing sweep efficiency<br>• Field complex fluids application and understating of mechanisms<br>• Simulation Software for Complex Fluids |
| **20b. Medienformen** | • Multimedia lecturing tools<br>• PowerPoint presentation software and white board<br>• A soft pdf copy of PowerPoint presentation with the Stud.IP directory (optionally)<br>• Computer aided exercises by using professional software |
| **21b. Literatur** | 1. Selected SPE papers and notes<br>2. R.E. Collins, Flow of Fluids Through Porous Materials, Petr. Pub. Co., 1976. J. Bear, Dynamics of Fluids in Porous Media, Elsevier, 1972; Dover, 1988. |
| **22b. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |
| **Zu Nr. 3:** | |
| **18c. Empf. Voraussetzungen** | Prerequisite is to attend the Fundamentals of Reservoir Simulation |
| **19c. Inhalte** | Contents:<br>• Compositional reservoir simulation (black oil vs. compositional)<br>• Simulation of gas storage (natural gas, hydrogen, CCS)<br>• Reactive transport (coupling diffusion, dispersion, rock-fluid interaction, micro-biological interaction)<br>• Simulation of fractured reservoirs (dual porosity, dual permeability and multiple permeability models)<br>• History matching (manual and computer assisted methods) |
| **20c. Medienformen** | • Powerpoint presentation<br>• Software demo and use |

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| **21c. Literatur** | 1. Inverse Theory for Petroleum Reservoir Characterization and History Matching, by D. Oliver, A. Reynolds and N. Liu, Cambridge University Press , ISBN 978-0521881517, 2008.<br>2. Reservoir Simulation: History Matching and Forecasting, by J. Gilman and C. Ozgen, SPE, ISBN 978-1-61399-292-0, 2013.<br>3. History Matching Standards; Quality Control and Risk Analysis for Simulation by R. Baker et al., Canadian International Petroleum Conference, 2006.<br>4. Top-Down Reservoir Modelling, by G.J. Williams et al., SPE paper 89974, 2004.<br>5. The Stratigraphic Method: A Structured Approach to History-Match Complex Simulation Models, by M.A. Williams et al., SPEREE, April 1998. |
| **22c. Sonstiges** | Participants are requested to register for the attendance with the course directory at the Stud.IP |

**Studien-/Prüfungsleistung**

| 23. Nr. | 24. Zugeordnete Lehrveranstaltungen | 25. P.-typ | 26. LP | 27. Benotung | 28. Anteil an der Modulnote |
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| 1 | Applied Rheology | MTP | 4 | graded | 1/3 |
| 2 | Micro and Macroscale Flow of Complex Fluids: Applications in EOR | MTP | 4 | graded | 1/3 |
| 3 | Advanced Reservoir Simulation with Complex Fluids | MTP | 4 | graded | 1/3 |

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| **29. Prüfungsform / Voraussetzung für die Vergabe von LP** | Partial examinations. Written (90 -120 min) or oral exam (30-60 min). At least 50% of maximal score number is required to pass the written exam. The module grade is evaluated as average grade from the partial grades weighted by the credit points. |
| **30. Verantwortliche(r) Prüfer(in)** | Prof. Jaeger, Dr. Hincapie, Prof. Ganzer |
| **31. Prüfungsvorleistungen** | None |