

University of Zagreb



Faculty of Mining, Geology and Petroleum Engineering



## Review of accredited graduate study programmes of petroleum engineering in European higher education area

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## 1. INTRODUCTION

The Faculty of Mining, Geology and Petroleum Engineering of the University of Zagreb is the only higher educational institution in the Republic of Croatia which organizes and conducts studies in the area of Petroleum Engineering at undergraduate, graduate and postgraduate level. The current curriculum consists of a three year (6 semesters; 180 ECTS) Undergraduate Study Program in Petroleum Engineering, followed by a two-year educational cycle (4 semesters; 120 ECTS) and finally a postgraduate study (6 semesters) as a part of doctoral programme *Applied Geosciences, Mining and Petroleum Engineering*. Currently all programmes at all mentioned study levels are carried out in Croatian.

Because of increased student mobility at all study levels the Faculty has decided to develop a new Graduate Petroleum Engineering Programme conducted entirely in English. The development of the programme is part of the Internalization of Faculty of Mining, Geology and Petroleum Engineering-InterRGN project which is completely financed by the European structural and investment funds. It is expected that applicants for the post graduate study programme which will be conducted in English will be Croatian citizens, citizens of neighbouring countries that do not have adequate or similar graduate studies in their respective countries or simply wish to study abroad. Similarly, we expect candidates to apply from other countries of the European Union, Europe and the rest of the world. Considering the wide range of possible applicants, the following section will give an overview of similarly accredited petroleum engineering graduate study programmes in the European higher education area. Programs that will be reviewed are programmes that are conducted exclusively in English.



## 2. UNIVERSITY OF LOEBEN

The University of Leoben has a longstanding tradition in education and producing high level experts in the field of petroleum engineering. Similarly, to the already existing study programme at RGNF Zagreb the study programme of Petroleum Engineering at Leoben University is organised in three stages starting with an undergraduate study that spans through 7 semesters which is closely followed by 4 semester graduate study and lastly the postgraduate doctorate programme which takes place over the course of 6 semesters. The focus of the afore mentioned programmes is placed on well drilling, oil and gas production, reservoir engineering, the exploitation of geothermal energy and business administration in petroleum engineering. These themes cover all fields within the scope of petroleum engineering. The University of Leoben also offers this degree as an international graduate degree (masters) in Petroleum Engineering that is conducted in English which is administered in cooperation with the Gubkin Russian State University of Oil and Gas. Since the introduction of the International Programmes at the Leoben University has terminated the graduate degree in German.

The most of professors that teach the study programmes in the field of Petroleum Engineering are members of the Department of Petroleum Engineering which was created in 2015 by merging the Chair of Drilling and Completion Engineering, the Chair of Petroleum and Geothermal Energy Recovery and the Chair of Reservoir Engineering (<https://dpe.ac.at/history/>). All afore mentioned Chairs have maintained their chair status under the new blanket department. The new Department therefore employs 50 persons, 8 of which make up the administration staff and the technical staff. Of the 610 students that are currently enrolled in the Petroleum Engineering Study Programme at various levels (422 at bachelor level, 170 at masters level and 18 postgraduate level), 33% is made up of international students, 16% are females and the ratio of students to professors is approximately 10:1. Most of the courses almost 75% of them have 25 or more students enrolled (<https://dpe.ac.at/facts-and-figures/>).

### *International Study Program in Petroleum Engineering (MSc)*

The preconditions for enrolment in the International Graduate Study Program in Petroleum Engineering are (<https://dpe.ac.at/apply/msc-petroleum-engineering/>):

- ✓ bachelor's degree in the field of engineering;
- ✓ 80 days of work experience or internship experience
- ✓ in depth knowledge of the English language which is proven with one of the following internationally recognised English language certifications
  - minimum score of 6,0 on the IELTS test (engl. *International English Language Testing System*);
  - minimum score of 80 point on the TOEFL (Eng. *Test of English as Foreign Language*) iBT test or otherwise a minimal score of 550 points on the TOEFL PBT test



- ✓ The university where students who are enrolling gained their undergraduate degrees must be classified H+ according to the ANabin scale.

Applicants that are not nationals of any countries within the EU must comply with and meet additional preconditions including the recognition or verification of documents issued by the state or university, such as the recognition of an equivalent of a high school diploma, etc. These documents must be translated in English or German and must be verified by a certified court interpreter and certified by an authorized person.

The expenses of enrolment in the University of Leoben have been standardised for all study programmes and they amount to 363,36 € per semester for all Austrian and EU citizens and 726,72 € for international and non-EU citizens respectively. Even though the payment rules apply to all students there are of course numerous exceptions, for instance all full-time EU students that complete their studies in the given period with ability for a one year extension are exempt from payment.

The study programme of Petroleum Engineering at the Leoben University is conceptualised through modules which allow for narrower and more focused specialisation of student in one of four areas (Drilling, Exploitation of Geothermal Energy, Petroleum Production and Reservoir Engineering). Table 1 shows a list of courses by semester and modules for the International graduate study of Petroleum Engineering.

Students that choose to enroll in the International graduate programme of Petroleum Engineering that is conducted at Leoben University have the option of choosing one of four available modules (Drilling, Exploitation of Geothermal Reservoirs, Petroleum Production and Reservoir Engineering). A list of all courses for the afore mentioned programme as well as their schedules by semester and modules can be found in table 1.

**Table 1.** List of courses by semester and modules for the International graduate study programme of Petroleum Engineering at Leoben University (<https://dpe.ac.at/msc-petroleum-engineering/courses/>)

| SEM.                | COURSE   | MANDATORY/<br>ELECTIVE | WEEK<br>SCHEDULE | ECTS | NOTE   |
|---------------------|--|------------------------|------------------|------|--|
| I (winter) semester | <i>Advanced Borehole Geophysics</i>                | mandatory              | 3 (L+P)          | 3,5  | These subjects are mandatory for all students regardless of which module they choose later on in the course. |
|                     | <i>Advanced Petroleum Economics Seminar</i>        | mandatory              | 3 (S)            | 4    |  |
|                     | <i>Computational Continuum Mechanics</i>           | mandatory              | 2 (L+P)          | 2,5  |  |
|                     | <i>Crisis Management in the Petroleum Industry</i> | mandatory              | 2 (L)            | 2    |  |
|                     | <i>Formation Impairment and Stimulation</i>        | mandatory              | 2 (L)            | 2    |  |
|                     | <i>Geomodelling</i>                                | mandatory              | 2 (L+P)          | 3    |  |
|                     | <i>Health, Safety and Environment</i>              | mandatory              | 2 (L)            | 2    |  |
|                     | <i>Petroleum Exploration</i>                       | mandatory              | 2 (L+P)          | 2,5  |  |

|   |   |           |         |   |  |  |
|---|---|-----------|---------|---|--|--|
| II (summer) semester                            | <i>Project Management for Industrial Management</i>                                 | mandatory | 2 (S)   | 3   |  |  |
|   | <i>Well Placement</i>   | mandatory | 2 (L+P) | 2,5   |  |  |
|   | <i>Wellbore and Reservoir Geomechanics</i>  | mandatory | 2 (L+P) | 3   |  |  |
|   | <i>Introduction to Field Development Project</i>                                    | mandatory | 1 (S)   | 2   | These subjects are mandatory for all students regardless of which module they choose later on in the course. |  |
|   | <i>Literature Review Project DE/PROD/RES/AGS</i>                                    | mandatory | 2 (S)   | 3   |  |  |
|   | <i>Practical Aspects of Field Development</i>                                       | mandatory | 2 (T)   | 1   |  |  |
|   | <b>Module: Drilling Engineering</b>   |           |         |   |  |  |
|   | <i>Advanced Well Construction</i>   | elective  | 4 (L+P) | 6   | Within the chosen module students must enroll in all elective courses within that module.                    |  |
|   | <i>Metallurgy and Corrosion for Petroleum Engineers</i>                             | elective  | 2 (L)   | 3   |  |  |
|   | <i>Offshore Technology</i>  | elective  | 3 (L+P) | 4   |  |  |
|   | <i>Well Construction Equipment</i>  | elective  | 2 (L+P) | 3   |  |  |
|   | <i>Well Control</i>   | elective  | 2 (L+P) | 3   |  |  |
|   | <i>Well Testing Operations</i>  | elective  | 2 (L+P) | 2   |  |  |
|   | <b>Module: Geothermal Engineering</b>   |           |         |   |  |  |
|   | <i>Advanced Well Construction</i>   | elective  | 4 (L+P) | 6   | Within the chosen module students must enroll in all elective courses within that module.                    |  |
|   | <i>Applied Geothermal Geophysics and Seismicity</i>                                 | elective  | 4 (L+P) | 4   |  |  |
|   | <i>Metallurgy and Corrosion for Petroleum Engineers</i>                             | elective  | 2 (L)   | 3   |  |  |
|   | <i>Principles of Shallow and Deep Geothermal Energy Recovery and Thermodynamics</i> | elective  | 2 (L+P) | 3   |  |  |
|   | <i>Reservoir Simulation Methods for Geothermal Engineers</i>                        | elective  | 2 (L+P) | 3   |  |  |
|   | <i>Surface Facilities for Geothermal Energy</i>                                     | elective  | 2 (L+P) | 2   |  |  |
|   | <b>Module: Petroleum Production Engineering</b>                                     |           |         |   |  |  |
|   | <i>Artificial Lift Systems</i>  | elective  | 2 (L)   | 3   | Within the chosen module students must enroll in all elective courses within that module.                    |  |
|   | <i>Artificial Lift Systems Practical</i>  | elective  | 3 (P)   | 3   |  |  |
|   | <i>Enhanced Oil Recovery</i>  | elective  | 2 (L+P) | 3   |  |  |
|   | <i>Metallurgy and Corrosion for Petroleum Engineers</i>                             | elective  | 2 (L)   | 3   |  |  |
|   | <i>Pipeline Engineering</i>   | elective  | 2 (L)   | 2,5   |  |  |
|   | <i>Reservoir Characterization and Modelling</i>                                     | elective  | 4 (L+P) | 5   |  |  |
| <i>Well Construction Equipment</i>              | elective  | 2 (L+P)   | 3       |   |  |  |
| <i>Well Testing Operations</i>                  | elective  | 2 (L+P)   | 2       |   |  |  |
| <b>Module: Reservoir Engineering</b>            |   |           |         |   |  |  |
| <i>Enhanced Oil Recovery</i>                    | elective  | 2 (L+P)   | 3       | Within the chosen module students must enroll in all elective courses |  |  |
| <i>Reservoir Characterization and Modelling</i> | elective  | 4 (L+P)   | 5       |   |  |  |



|  |  |           |         |  |   |   |
|--|--|-----------|---------|--|---|---|
| III (winter) semester                                | <i>Reservoir Engineering 2: Advanced Concepts for Conventional Resources</i>   | elective  | 2 (L+P) | 3  |   |   |
|  | <i>Reservoir Simulation Methods I</i>  | elective  | 4 (L+P) | 5  |   |   |
|  | <i>Water Flooding</i>  | elective  | 2 (L+P) | 3  |   |   |
|  | <i>Field Development Project</i>   | mandatory | 1 (S)   | 3  | 3   | This course is mandatory for all students regardless of which module they choose. |
|  | <b>Module: Drilling Engineering</b>  |           |         |  |   |   |
|  | <i>Advanced Well Monitoring and Analysis</i>                                   | elective  | 3 (L+P) | 3  | Within the chosen module students must enroll in all elective courses within that module. |   |
|  | <i>Drilling Process Evaluation and Planning</i>                                | elective  | 2 (L+P) | 3  |   |   |
|  | <i>Measurement Control, Monitoring and Analysis</i>                            | elective  | 3 (L+P) | 4  |   |   |
|  | <i>Well Construction Fluids Lab</i>  | elective  | 3 (L+P) | 3  |   |   |
|  | <i>Well Construction Mechanical Lab</i>  | elective  | 2 (L+P) | 3  |   |   |
|  | <i>Well Construction Problems and Solutions</i>                                | elective  | 2 (L)   | 4  |   |   |
|  | <i>Well Integrity</i>  | elective  | 2 (L+P) | 3  |   |   |
|  | <b>Module: Geothermal Engineering</b>  |           |         |  |   |   |
|  | <i>Advanced Geothermal Drilling and Completion</i>                             | elective  | 2 (L+P) | 3  | Within the chosen module students must enroll in all elective courses within that module. |   |
|  | <i>Decision-Making and Risk Analysis</i>                                       | elective  | 3 (L+P) | 4  |   |   |
|  | <i>Energy Transport and Network</i>  | elective  | 2 (L+P) | 3  |   |   |
|  | <i>Geothermal Reservoir Modeling</i>   | elective  | 4 (L+P) | 5  |   |   |
|  | <i>Subsurface Production System Design, Flow Assurance and Artificial Lift</i> | elective  | 4 (L+P) | 5  |   |   |
|  | <i>Well Integrity</i>  | elective  | 2 (L+P) | 3  |   |   |
|  | <b>Module: Petroleum Production Engineering</b>                                |           |         |  |   |   |
|  | <i>Advanced Oil, Gas and Geothermal Energy Recovery</i>                        | elective  | 2 (L)   | 2  | Within the chosen module students must enroll in all elective courses within that module. |   |
|  | <i>Energy Efficiency in Petroleum Production</i>                               | elective  | 3 (L+P) | 3,5  |   |   |
|  | <i>Natural Gas Technology</i>  | elective  | 2 (L)   | 3  |   |   |
| <i>Nodal Analysis</i>                                | elective   | 2 (L+P)   | 3       |  |   |   |
| <i>On- and Offshore Production Facilities</i>        | elective   | 3 (L)     | 4       |  |   |   |
| <i>Production Data Analysis and Modelling</i>        | elective   | 4 (L+P)   | 4       |  |   |   |
| <b>Module: Reservoir Engineering</b>                 |  |           |         |  |   |   |
| <i>Enhanced Oil Recovery in Fractured Reservoirs</i> | elective   | 2 (L+P)   | 3       | Within the chosen module students must enroll in all |   |   |
| <i>Nodal Analysis</i>                                | elective   | 2 (L+P)   | 3       |  |   |   |



|                      |  |           |         |        |  |
|----------------------|--|-----------|---------|--------|--|
|                      | <i>Reservoir Engineering 2: Storage, Sequestration and Geothermal Energy</i> | elective  | 2 (L+P) | 3      |  |
|                      | <i>Reservoir Engineering 2: Unconventional Resources</i>                     | elective  | 2 (L+P) | 3      |  |
|                      | <i>Reservoir Management</i>  | elective  | 4 (L+P) | 5      |  |
|                      | <i>Reservoir Simulation Methods II: Advanced Concepts</i>                    | elective  | 4 (L+P) | 5      |  |
|                      | <i>Special Core Analysis</i>   | elective  | 2 (L+P) | 3      |  |
| IV (summer semester) | <i>Master's Thesis</i>   | mandatory |         | 34 -37 |  |

Legend: L (Lecture), P (Practice), S (Seminars)

Through analysis of data showing in Table 1 the conclusion is drawn that the first (winter) semester which is mandatory for all students consists of 24 hours of varying forms of study a week (30 ECTS). The second (summer) semester consists of 5 hours of mandatory classes a week for all students while the remaining classes are elective and vary from 14 to 19 hours a week (21 to 24,5 ECTS) depending on the module and with the condition that any student who chooses a specific module must undertake all electives within the pertaining module. In the third (winter) semester students have one mandatory class a week (3 ECTS) whereas the rest of the classes are elective which vary from 16 to 18 hours a week (19 to 25 ECTS) dependent on the chosen module and with the condition that any student who chooses a specific module must undertake all electives within the pertaining module. The final semester is imagined for the completion of the master thesis, necessary research and the final exam. Weekly responsibilities and workload for students vary depending on the chosen module in each semester. When all hours of weekly classes and ECTS points are added having in mind that students have chosen their own modules it can be concluded that through the duration of their studies students have from 51,6 to 53,8% of elective hours of class though they makeup close to 53% of the required ECTS points (the mentioned figures do not include the final exam and thesis).

The master thesis is to be written in the field or module that the student had chosen for their study. In accordance with the chosen theme, a mentor is assigned to all students who helps guide and assist the student in writing a principal proposal for the master thesis. The time given for the completion of the master thesis which is to be anywhere between 60 and 80 pages is a minimum 5 months. The master thesis must be defended at least a week before the final master's exam. The process of defending one's thesis is includes a 20-minute presentation and a 40-minute Q&A. The master's exam has a duration of 50 minutes and it consists of a short presentation of the thesis (max. three slides), an oral exam in the chosen field or study covered by the chosen module (35 minutes) and an oral exam in the module that is covered by the other two departments (20 minutes).

### ***Joint International Master Program in Petroleum Engineering „Advance Well Construction and Operation Technologies“***

The Joint International Graduate Study Program in Petroleum Engineering was designed under the Agreement on Scientific and Technical Cooperation between Gazprom PJSC, OMV, the University of Leoben and the Gubkin Russian State University of Oil and Gas. The afore mentioned companies are sponsors of the study programme and annually they offer seven scholarships that cover all costs of studying. The aim of this joint international graduate programme is to solve an array of problems that oil and gas companies frequently encounter. For these reasons experts from the mentioned companies play a pivotal role as mentors and guides in the practical portion of the study as well as mentors in the perpetration and execution of master thesis. With the completion of said study students gain a double degree.

The preconditioned requirements for the Joint international graduate study of Petroleum Engineering in English are (<https://dpe.ac.at/apply/msc-double-degree-joint-int-master-program-in-pe/>):

- ✓ high school diploma
- ✓ bachelor's degree in the field of petroleum engineering
- ✓ knowledge of the English language which must be proven with one of the following internationally recognized test
  - minimum result of 6,0 on the IELTS test (Eng. *International English Language Testing System*);
  - minimum of 80 points on the TOEFL (Eng. *Test of English as Foreign Language*) iBT test or a minimum of 550 on the TOEFL PBT test;
- ✓ A skype interview with the international committee.
- ✓ The university where students who are enrolling gained their undergraduate degrees must be classified H+ according to the Anabin scale (applies only to non-EU students).
- ✓ Proof of work or internship experience (applies only to non-EU students).

Applicants that are not nationals of any countries within the EU must comply with and meet additional preconditions including the recognition or verification of documents issued by the state or university, such as the recognition of an equivalent of a high school diploma, etc. These documents must be translated in English or German and must be verified by a certified court interpreter and certified by an authorized person. Table 1 provides an overview of courses by semester that are performed within this joint study.

**Table 2.** List of courses by semester and modules for the Joint International Graduate Study Programme of Petroleum Engineering at Leoben University and Gubkin Russian State University for Oil and Gas conducted in English (<https://dpe.ac.at/joint-double-degree-msc-pe/courses/>)

| SEM                   | COURSE  | MANDATORY/ELECTIVE | WEEK SCHEDULE | ECTS | NOTE   |
|-----------------------|---|--------------------|---------------|------|--|
| I (winter) semester   | <i>Advanced Borehole Geophysics</i>   | mandatory          | 3 (L+P)       | 3,5  | Total number of students that are enrolled in the joint study programme attend the class in Leoben University. |
|                       | <i>Advanced Petroleum Economics Seminar</i>   | mandatory          | 3 (S)         | 4    |  |
|                       | <i>Computational Continuum Mechanics</i>  | mandatory          | 2 (L+P)       | 2,5  |  |
|                       | <i>Flow of Fluids in Wells and Pipes</i>  | mandatory          | 2 (L+P)       | 2    |  |
|                       | <i>Material Engineering in the Oil and Gas Industry</i>   | mandatory          | 4 (L+P)       | 4    |  |
|                       | <i>Mathematical Foundations for Data Measurement</i>  | mandatory          | 2 (L+P)       | 3    |  |
|                       | <i>The O&amp;G Industry Machine and Equipment Design &amp; Simulation</i>   | mandatory          | 3 (L+P)       | 3,5  |  |
|                       | <i>Well Integrity</i>   | mandatory          | 2 (L+P)       | 3    |  |
|                       | <i>Well Placement</i>   | mandatory          | 2 (L+P)       | 2,5  |  |
| II (summer) semester  | Unfortunately, it is not possible to find information on subjects performed at the Gubkin University in II (summer semester). |                    |               |      | Total number of students that are enrolled in the joint study programme attend the class in Gubkin University. |
| III (winter) semester | <i>Advanced Directional Drilling and Geo-steering</i>   | mandatory          | 3 (L+P)       | 5    |  |
|                       | <i>Advanced Well Monitoring and Analysis</i>  | mandatory          | 3 (L+P)       | 3    |  |
|                       | <i>Drilling Process Evaluation and Planning</i>   | mandatory          | 2 (L+P)       | 3    |  |
|                       | <i>Health, Safety and Environment</i>   | mandatory          | 2 (L)         | 2    |  |
|                       | <i>Measurement Control, Monitoring and Analysis</i>   | mandatory          | 3 (L+P)       | 4    |  |
|                       | <i>Well Construction Fluids Lab</i>   | mandatory          | 2 (L+P)       | 3    |  |
|                       | <i>Well Construction Mechanical Lab</i>   | mandatory          | 2 (L+P)       | 3    |  |
|                       | <i>Well Reconstruction, Restoration, Plug and Abandonment</i>   | mandatory          | 2 (L+P)       | 2    |  |
|                       | <i>Wellbore and Reservoir Geomechanics</i>  | mandatory          | 2 (L+P)       | 3    |  |
| IV (summer) semester  | <i>Master's Thesis</i>  | mandatory          |               |      |  |

**Legend:** L (Lecture), P (Practice), S (Seminars)

As can be seen in data provided in table 2, the Joint International study Programme does not allow the option of elective courses, but instead the programme consists of predefined and chosen mandatory courses which is in agreement with the initial intention in the formation of this study programme. This intention being that each student directed to a specific area of Petroleum Engineering. The weekly workload for students comes in the form of 23 hours of class a week in semester one (winter) and 21 hours a week in semester three (winter) and the number of ECTS points for all courses in both semesters adds up to 28 points (unfortunately data for the semester that is held at Gubkin University is not available).

Similar to the International graduate study of Petroleum Engineering at the same university, the Joint international graduate study of Petroleum Engineering ends with a master thesis, the defence of the master thesis and a final exam. Considering that the joint study is more related to the area of manufacturing and well completion, students must find their mentor in the Chair of Drilling and Well Completion. The expected time frame for research and completion of the master thesis is 5 months and should consist of 60 to 80 pages not including appendages that are an integral part of the thesis. Defence of the thesis similarly consists of a 20-minute presentation and a 10 to 20-minute Q&A from the panel. The master exam consists of a presentation of the thesis in duration of no more than 5 minutes and an oral exam from 2 out of 4 given fields: Data Acquisition and Analysis, Solid and Fluid Mechanics, Economics and Management and Drilling and completion.

### 3. UNIVERSITY OF MISKOLC

*Faculty of Earth Science and Engineering* at the University of Miskolc (Hungary) offers a few graduate study programmes in English. Among these is two-years graduate programme in Petroleum Engineering. Under *the Institute of Petroleum and Natural Gas* as a part of *the Faculty of Earth Science and Engineering* two departments were established in 1993 - *Department of Petroleum Engineering* and *Department of Natural Gas Engineering*. University of Miskolc has a long history of research and education in Petroleum Engineering. The Petroleum Engineering Department of the University of Miskolc is the only institution in Hungary offering Petroleum Engineering programs. It has been training capable Petroleum Engineering graduates since 1951. First integrated graduate Petroleum Engineering study in English was established in 1987.

Tuition fee for MSc in Petroleum Engineering is 3500 € per semester (reduced fee may be applied depending on academic achievement from the third semester), regardless of whether the enrollees are citizens of EU or international outside of EU. It is important to mention, that there is a large number of available scholarships for future students.

The preconditions for enrolment in the Graduate Study in Petroleum Engineering in English at the University of Miskolc are ([http://mfk.uni-miskolc.hu/wp/en/wp-content/uploads/2015/05/Application-Criteria\\_PE1.pdf](http://mfk.uni-miskolc.hu/wp/en/wp-content/uploads/2015/05/Application-Criteria_PE1.pdf)):

- ✓ BSc in petroleum engineering degree, CGPA 60% or higher,
- ✓ English language proficiency: C1 (advanced) level is preferred, but minimum B2 on the CEFR scale,
- ✓ IELTS (academic version) 5.5 minimum score or identical language exam.
- ✓ BSc degree holders, if the language of instruction was English are exempt from language test requirement.

In addition to afore mentioned requirements, students must submit additional documents as: curriculum vitae (Resume) in English, copy of passport or ID card with personal data, copy of BSc (or identical) diploma and motivation letter. Additionally, every applicant has a Skype-based video conference with program leader to evaluate the professional and language skills as well as motivation of the applicant for chosen study. In the Table 3 overview of the Petroleum Engineering Graduate Program in English at the University of Miskolc is shown.

**Table 3.** List of courses by semester for Graduate Study Programme of Petroleum Engineering at University of Miskolc conducted in English (<http://mfk.uni-miskolc.hu/wp/en/wp-content/uploads/2017/02/Curriculum-of-the-program-course-list.pdf>)

| SE M.                 | COURSE  | MANDATORY /ELECTIVE | SATNICA | ECTS | NOTE  |
|-----------------------|---|---------------------|---------|------|---|
| I (winter) semester   | <i>Numerical methods and optimization</i>       | mandatory           | 2 (L+P) | 2    |   |
|                       | <i>Applied Geology</i>                          | mandatory           | 3 (L+P) | 3P   |   |
|                       | <i>Computer Applications I</i>                  | mandatory           | 3 (L)   | 3    |   |
|                       | <i>Applied Geophysics</i>                       | mandatory           | 3 (L+P) | 3    |   |
|                       | <i>Oilfield Chemistry</i>                       | mandatory           | 3 (L+P) | 3    |   |
|                       | <i>Geothermal Energy</i>                        | mandatory           | 2 (L)   | 3    |   |
|                       | <i>Petroleum Economics</i>                      | mandatory           | 2 (L)   | 2    |   |
|                       | <i>HSE in Petroleum Engineering</i>             | mandatory           | 2 (L)   | 3    |   |
|                       | <i>Mandatory elective I.</i>                    | elective            | 2 (L)   | 2    | The term mandatory electives unfortunately in not defined anywhere. |
|                       | <i>Mandatory elective II.</i>                   | elective            | 2 (L)   | 2    | The term mandatory electives unfortunately in not defined anywhere. |
|                       | <i>Free Electives: Geothermal Well Drilling</i> | elective            | 2 (L)   | 2    |   |
| II (summer) semester  | <i>Computer Applications II.</i>                | mandatory           | 3 (P)   | 3    |   |
|                       | <i>Graduate Research Seminar</i>                | mandatory           | 1 (P)   | 2    |   |
|                       | <i>Drilling engineering I.</i>                  | mandatory           | 4 (L+P) | 6    |   |
|                       | <i>Well Control Lab</i>                         | mandatory           | 3 (P)   | 3    |   |
|                       | <i>Production Engineering Fundamentals</i>      | mandatory           | 4 (L+P) | 6    |   |
|                       | <i>Artificial Lifting I</i>                     | mandatory           | 3 (L)   | 3    |   |
|                       | <i>Reservoir Engineering Fundamentals</i>       | mandatory           | 4 (L+P) | 6    |   |
|                       | <i>Fluid Mechanics</i>                          | mandatory           | 3 (L)   | 3    |   |
| III (winter) semester | <i>Drilling engineering II.</i>                 | mandatory           | 4 (L+P) | 5    |   |
|                       | <i>Artificial Lifting II</i>                    | mandatory           | 4 (L+P) | 6    |   |
|                       | <i>Flow in Porous Media</i>                     | mandatory           | 3 (P)   | 3    |   |
|                       | <i>Material Balance</i>                         | mandatory           | 3 (L+P) | 3    |   |
|                       | <i>Transport of Hydrocarbons</i>                | mandatory           | 2 (L)   | 2    |   |
|                       | <i>Thesis work I</i>                            | mandatory           | 13 (P)  | 13   |   |
| IV (summer) semester  | <i>Well Completion Design</i>                   | mandatory           | 3 (L+P) | 3    |   |
|                       | <i>NODAL Analysis Applications</i>              | mandatory           | 2 (P)   | 2    |   |
|                       | <i>EOR Methods</i>                              | mandatory           | 3 (L+P) | 3    |   |
|                       | <i>Reservoir Management Simulation Lab</i>      | mandatory           | 3 (P)   | 3    |   |



|  |                       |           |        |    |  |
|--|-----------------------|-----------|--------|----|--|
|  |                       |           |        |    |  |
|  | <i>Thesis work II</i> | mandatory | 17 (P) | 17 |  |

**Note:** More information about courses content, goals and outcomes as well as exams passing can be found in documents at the website (<http://mfk.uni-miskolc.hu/wp/en/wp-content/uploads/2017/02/Syllabuses-of-the-program.pdf>)

**Legend:** L (Lecture) P (Practice), S (Seminars)

According to the data shown in Table 3, it can be seen that the Graduate Study Programme of Petroleum Engineering in English, carried out by the University of Miskolc, lasts for the duration of 2 years, i.e., 4 semesters. Upon completion, the enrollee acquires a total of 120 ECTS points. The weekly student workload for different forms of lessons, differentiates according to semester and varies from 25 to 29 hours. Selective courses in this study programme are minimal and the courses amount to 2 obligatory and 1 selective course in the first semester. During study, the student is obligated to finish traineeship with a minimum duration of 4 weeks. After the student has successfully carried out his obligations with accordance to the study programme, i.e., passing all courses both selective and mandatory, finishing his/her traineeship and writing the thesis, he is able to defend his thesis and take the graduate exam. The graduate exam is conducted orally and covers the fields of Drilling Engineering and Well Completion, Reservoir Mechanics and Petroleum Production Technology. From the previously mentioned areas, the student is graded on a scale (from 1 to 5) and the minimum grade for successfully passing the exam is 2 for each field of study. The total grade is calculated as the average value of the thesis defence grade as well as the average grade from the 3 thematic sections.



#### 4. TECHNICAL UNIVERSITY OF CLAUSTHAL

Technical University of Clausthal has a long tradition in the area of mining and petroleum engineering education. Teaching area was about oil and mining industry since 1920. Institute of Petroleum Engineering at the Technical University of Clausthal was established in 1943 due to increasingly growing significance of fossil fuels in the world and the need to establish educational organizations specialized for research and education in the field of hydrocarbon exploration and production. Institute of Petroleum Engineering changed the name to today's *Institute of Subsurface Energy Systems* in order to widespread the scientific and professional focus on the energy transition as well as geothermal systems related projects, subsurface energy storage etc. Scientific research, teaching and professional work of the Institute are carried out in few departments with 47 permanent employees and 19 external lecturers. The institute is the only one in Germany that offers a Master of Science Program in Petroleum Engineering, which are entirely conducted in English. The duration of the Master's programme is 2 years (4 semesters) with the possibility of specialization in three directions: *Reservoir Management, Drilling & Production Technology and Deep Geothermal Systems*. The requirement for successfully finishing the study is a minimum of 120 ECTS points obtained, from which 28 are obtained by successfully writing and defending the master's thesis.

The preconditions for enrolment in the Graduate Study in Petroleum Engineering in English at the University of Clausthal are (<https://www.ite-clausthal.de/en/studies/studies>):

- ✓ bachelor's degree with a specialization in petroleum engineering from a recognised (specialist) university or an equivalent qualification (In the absence of equivalence, authorisation is course to conditions);
- ✓ proficiency in English proved through:
  - at least 79 points at TOEFL iBT,
  - minimum of 1050 points at TOEIC,
  - minimum of 6.5 points at an IELTS.

In addition to afore mentioned documents, the application documents must also include: Curriculum vitae (Curriculum), cover letter, certified copy of the school leaving certificate, if necessary, with a translation into German or English, in the case of a foreign bachelor's degree, proof that bachelor's degree programme is accredited etc. During the enrollment foreign students will pay between 55 and 75 € if foreign certificates for the application process have to be viewed and translated. Excluded from the fees are students from another German university, students who have a European nationality, participate in the Erasmus+ and cooperation programmes or students supported by a German scholarship.



All full-time students are exempt from tuition fees, the only expenditure being enrollment fees for various administrative costs and costs of student association membership totalling 190€. The institute, as an organizational unit within the Technical University of Clausthal, does not offer student stipends at their study programmes, but all students are able to apply for any of the scholarship programmes through the DAAD.

The study programme is organized on the principle of mandatory, mandatory-selective and selective modulees and submodulees. When compared to the university of Leoben, these bundles of courses are relating to a specific course. With the combination of modulees, the students are steered toward one of the three aforementioned areas. Table 4 shows the list of the courses per semester, modulees and submodulees at the Graduate study programme of petroleum engineering at the Technical University of Clausthal conducted in English.

**Table 4.** List of courses by semester at the Graduate Study Programme in Petroleum Engineering at the Technical University of Clausthal conducted in English ([https://www.tu-clausthal.de/fileadmin/TU\\_Clausthal/dokumente/Studiengaenge/Ausfuehrungsbestimmung\\_en/AFB\\_Petroleum\\_Engineering\\_MSc\\_21.07.2015\\_3\\_%C3%84nderung\\_25.06.2019\\_ENGLISH.pdf](https://www.tu-clausthal.de/fileadmin/TU_Clausthal/dokumente/Studiengaenge/Ausfuehrungsbestimmung_en/AFB_Petroleum_Engineering_MSc_21.07.2015_3_%C3%84nderung_25.06.2019_ENGLISH.pdf) )

| SE M.               | COURSE  | MODULE  | MANDATORY/ELECTIVE  | WEEK SCHEDULE      | ECTS   | NOTE  |  |
|---------------------|---|---|---------------------|--------------------|--|---|--|
| I (winter) semester | <i>Technical Writing</i>                                    | Mandatory module 1 - <i>Communication Skills</i>                  | mandatory           | 2 (2P)             | 2  | Mandatory for all students.   |  |
|                     | <i>Thermodynamics &amp; Phase Behaviour of Hydrocarbons</i> | Mandatory module 2 - <i>Advanced Reservoir Mechanics</i>          | mandatory           | 3 (2L+1P)          | 5  | Mandatory for all students.   |  |
|                     | <i>Rock Mechanics II</i>                                    | Mandatory module 2 - <i>Advanced Reservoir Mechanics</i>          | mandatory           | 3 (2L+1P)          | 5  | Mandatory for all students.   |  |
|                     | <i>Advanced Production</i>                                  | Mandatory module 3 - <i>Advanced Production and Well Planning</i> | mandatory           | 3 (2L+1P)          | 5  | Mandatory for all students.   |  |
|                     | <i>Well Planing</i>   | Mandatory module 3 - <i>Advanced Production and Well Planning</i> | mandatory           | 3 (2L+1P)          | 5  | Mandatory for all students.   |  |
|                     | <b>Direction: Reservoir Management</b>                      |   |                     |                    |  |   |  |
|                     | <i>Geological Modeling</i>                                  | Mandatory module 5 - <i>Reservoir Modeling and Simulation</i>     | mandatory           | 3 (2P+1V)          | 5  | Mandatory course for all students that have chosen the direction Reservoir Management.      |  |
|                     | Elective course   | Elective module 15 - <i>Advanced Rock Characterization</i>        | elective            | 3 (2L+1P)          | 5  | The student is able to choose one of the courses that is offered within elective module 15. |  |
|                     | <b>Direction: Drilling/Production</b>                       |   |                     |                    |  |   |  |
|                     | <i>Advanced Drilling Technology</i>                         | Mandatory module 7 - <i>Advanced Drilling Technology</i>          | mandatory           | 3 (2L+1P)          | 5  | Mandatory course for all students that have chosen the direction Drilling/ Production.      |  |
| Elective course     | Elective module 19 - <i>Drilling/production</i>             | elective  | Workload depends on | ECTS points depend | The student has a choice of one or two courses from elective |   |  |

|   |                  |   |                     |   |  |   |
|---|------------------|---|---------------------|---|--|---|
|   |                  |   | course(s) enrolled. | on courses enrolled.                    | module 19 which amounts to 5 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 19 during the course of their study. |   |
| <b>Direction: Deep Geothermal Systems</b> |                  |   |                     |   |  |   |
| <i>Advanced Technology</i>                | <i>Drilling</i>  | <b>Mandatory module 7 – Nove tehnologije izrade bušotina</b> (engl. <i>Advanced Drilling Technology</i> ) | mandatory           | 3 (2L+1P)                               | 5  | This is a mandatory course for all students that have chosen the direction Drilling/Production.   |
| Elective course                           |                  | <b>Elective module 20 – Duboki geotermalni sustavi</b> (engl. <i>Deep Geothermal Systems</i> )            | elective            | Workload depends on course(s) enrolled. | ECTS points depend on course enrolled.   | The student has a choice of one or two courses from elective module 20 which amounts to 5 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 20 during the course of their study. |
| <i>Interpersonal Skills</i>               |                  | <b>Mandatory module 1 - Communication Skills</b>  | mandatory           | 2 (2P)                                  | 3  | Mandatory for all students.   |
| <b>Direction: Reservoir Management</b>    |                  |   |                     |   |  |   |
| <i>Energy Law</i>                         |                  | <b>Mandatory module 10a - Economics and Law</b>   | mandatory           | 1 (1P)                                  | 2  | Mandatory course for all students that have chosen the direction Reservoir Management.  |
| <i>Applied Well Test Analysis</i>         |                  | <b>Mandatory module 4 - Data Acquisition and Evaluation</b>   | mandatory           | 3 (2L+1P)                               | 5  | Mandatory course for all students that have chosen the direction Reservoir Management.  |
| <i>Well Logging II</i>                    |                  | <b>Mandatory module 4 - Data Acquisition and Evaluation</b>   | mandatory           | 3 (2L+1P)                               | 5  | Mandatory course for all students that have chosen the direction Reservoir Management.  |
| <i>Numerical Reservoir Simulation</i>     | <i>Reservoir</i> | <b>Mandatory module 5 – Reservoir Modeling and Simulation</b>   | mandatory           | 3 (2L+1P)                               | 5  | Mandatory course for all students that have chosen the direction Reservoir Management.  |
| <i>Advanced Topics</i>                    | <i>Reservoir</i> | <b>Mandatory module 12 – Seminar Seminar</b>  | mandatory           | 2 (2S)                                  | 4  | Mandatory course for all students that have chosen the direction Reservoir Management.  |
| Elective course                           |                  | <b>Elective module 16 – Advanced Reservoir Engineering)</b>   | elective            | Workload depends on course(s) enrolled. | 4  | The student is able to choose one of the courses that is offered within elective module 16.   |
| Elective course                           |                  | <b>Elective module 17 – Enhanced Production Engineering</b>   | elective            | Workload depends on course(s) enrolled. | 4  | The student is able to choose one of the courses that is offered within elective module 17.   |

| Direction: Drilling/Production                         |   |           |   |  |   |
|--|---|-----------|---|--|---|
| Energy Law   | Mandatory module 10b - Management, Economics and Law  | mandatory | 1 (1L)                                  | 2                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Well Logging II  | Mandatory module 8 - Directional drilling and Logging | mandatory | 3 (2L+1P)                               | 5                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Selective Chapters in Advanced Drilling and Production | Mandatory module 12 - Seminar                         | mandatory | 2 (2S)                                  | 4                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Directional Drilling                                   | Mandatory module 8 - Directional Drilling and Logging | mandatory | 2 (2L)                                  | 4                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Enhanced Production                                    | Mandatory module 9 - Production                       | mandatory | 2 (2L)                                  | 4                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Completion and Workover                                | Mandatory module 7 - Advanced Drilling and Completion | mandatory | 3 (2L+1P)                               | 5                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Advanced Hydrocarbon Conditioning & Processing         | Mandatory module 9 - Production                       | mandatory | 2 (2L)                                  | 3                                      | Mandatory course for all students that have chosen the direction Drilling/ Production.  |
| Elective course  | Elective module 19 – Drilling/Production              | elective  | Workload depends on course(s) enrolled. | ECTS points depend on course enrolled. | The student has a choice of one or two courses from elective module 19 which amounts to 4 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 19 during the course of their study. |
| Direction: Deep Geothermal Systems                     |   |           |   |  |   |
| Energy Law   | Mandatory module 10a - Economics and Law              | mandatory | 1 (1L)                                  | 2                                      | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |
| Well Logging II  | Mandatory module 4 - Data Acquisition and Evaluation  | mandatory | 3 (2L+1P)                               | 5                                      | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |
| Selected chapters in Advanced Geothermal Engineering   | Mandatory module 12 – Seminar                         | mandatory | 2 (2S)                                  | 4                                      | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |
| Applied Well Test Analysis                             | Mandatory module 4 - Data Acquisition and Evaluation  | mandatory | 3 (2L+1P)                               | 5                                      | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |
| Completion and Workover                                | Mandatory module 7 - Advanced Drilling and Completion | mandatory | 3 (2L+1P)                               | 5                                      | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |

|   |  |   |           |   |   |   |  |
|---|--|---|-----------|---|---|---|--|
|   | <i>Enhanced Geothermal Systems</i>                   | <b>Mandatory module 14 - Geothermal Systems</b>             | mandatory | 2 (2L)                                  | 4   | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |  |
|   | <i>Elective course</i>                               | <b>Elective module 20 – Deep Geothermal Systems</b>         | elective  | Workload depends on course(s) enrolled. | ECTS points depend on course enrolled.  | The student has a choice of one or two courses from elective module 19 which amounts to 5 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 19 during the course of their study. |  |
| III (winter) semester                     | <i>Integrated Project and Management Development</i> | <b>Project Management</b>                                   | mandatory | 4 (4L)                                  | 6   | Mandatory for all students.   |  |
|   | <i>Group Project</i>                                 | <b>Mandatory module 13 - Group Project</b>                  | mandatory | 6 (6 Praktikum)                         | 12  | Mandatory for all students.   |  |
|   | <b>Direction: Reservoir Management</b>               |   |           |   |   |   |  |
|   | <i>Enhanced Oil Recovery</i>                         | <b>Mandatory module 6 – Enhanced Oil Recovery</b>           | mandatory | 3 (2L+1P)                               | 5   | Mandatory course for all students that have chosen the direction Reservoir Management.  |  |
|   | <i>Planning &amp; Budgeting</i>                      | <b>Mandatory module 10a - Economics and Law</b>             | mandatory | 2 (2L)                                  | 3   | Mandatory course for all students that have chosen the direction Reservoir Management.  |  |
|   | <i>Elective course</i>                               | <b>Elective module 18 – Management and Law</b>              | elective  | Workload depends on course enrolled.    | ECTS points depend on course enrolled.  | The student is able to choose one of the courses that is offered within elective module 18.   |  |
|   | <b>Direction: Drilling/Production</b>                |   |           |   |   |   |  |
|   | <i>Planning &amp; Budgeting</i>                      | <b>Mandatory module 10b - Management, Economics and Law</b> | mandatory | 2 (2L)                                  | 3   | Mandatory course for all students that have chosen the direction Drilling/ Production.  |  |
|   | <i>Health, Safety and Environmental Management</i>   | <b>Mandatory module 10b - Management, Economics and Law</b> | mandatory | 1 (1L)                                  | 2   | Mandatory course for all students that have chosen the direction Drilling/ Production.  |  |
|   | <i>Elective course</i>                               | <b>Elective module 19 – Drilling/Production</b>             | elective  | Workload depends on course enrolled.    | ECTS points depend on courses enrolled.   | The student has a choice of one or two courses from elective module 19 which amounts to 3 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 19 during the course of their study. |  |
| <b>Direction: Deep Geothermal Systems</b> |  |   |           |   |   |   |  |
| <i>Planning &amp; Budgeting</i>           | <b>Mandatory module 10a - Economics and Law</b>      | mandatory   | 2 (2L)    | 3                                       | Mandatory course for all students that have chosen the direction Deep Geothermal Systems. |   |  |



|                      |   |   |           |   |   |   |
|----------------------|---|---|-----------|---|---|---|
|                      | <i>Geothermal Energy Production Systems</i> | <b>Mandatory module 14 - Geothermal Systems</b>     | mandatory | 2 (2L)                                  | 4                                       | Mandatory course for all students that have chosen the direction Deep Geothermal Systems.   |
|                      | <i>Elective course</i>                      | <b>Elective module 20 – Deep Geothermal Systems</b> | elective  | Workload depends on course(s) enrolled. | ECTS points depend on courses enrolled. | The student has a choice of one or two courses from elective module 20 which amounts to 3 or more ECTS. Whilst choosing the elective courses the student must be aware that they can choose courses that add to a maximum amount of 15 ECTS points in module 20 during the course of their study. |
| IV (summer) semester | <i>Master Thesis</i>                        |   | mandatory |   | 28                                      |   |

Legend: L (Lecture), P (Practice), S (Seminars)

Table 4a shows the list of submodules and courses in elective modules from 15 to 20.

**Table 4a.** List of submodules and courses in elective modules from 15 to 20 ([https://www.tu-clausthal.de/fileadmin/TU\\_Clausthal/dokumente/Studiengaenge/Ausfuehrungsbestimmung\\_en/AFB\\_Petroleum\\_Engineering\\_MSc\\_21.07.2015\\_3\\_2019\\_GLISH.pdf](https://www.tu-clausthal.de/fileadmin/TU_Clausthal/dokumente/Studiengaenge/Ausfuehrungsbestimmung_en/AFB_Petroleum_Engineering_MSc_21.07.2015_3_2019_GLISH.pdf) )

| SUBMODULE  | ELECTIVE PREDMET UNUTAR SUBMODULEA                 | WEEK SCHEDULE | ECTS |
|--|--|---------------|------|
| <b>Elective module 15 – Advanced Rock Characterisation</b>                           |  |               |      |
| <b>Elective submodule 15.1</b><br><i>Petrophysics</i>                                | <i>Petrophysics I</i>                              | 3 (2L+1P)     | 5    |
| <b>Elective submodule 15.2</b><br><i>Geostatistics</i>                               | <i>Advanced Geostatistics</i>                      | 3 (2L+1P)     | 5    |
| <b>Elective submodule 15.3</b><br><i>Rock Physics</i>                                | <i>Advanced Rock Physics</i>                       | 3 (2L+1P)     | 5    |
| <b>Elective module 16 – Advanced Reservoir Engineering</b>                           |  |               |      |
| <b>Elective submodule 16.1</b><br><i>Data Interpretation</i>                         | <i>Applied Seismic Data Interpretation</i>         | 3 (2L+1P)     | 4    |
| <b>Elective submodule 16.2</b><br><i>Model Validation</i>                            | <i>Reservoir Model Validation</i>                  | 2 (2L)        | 4    |
| <b>Elective submodule 16.3</b><br><i>Reservoir Modelling</i>                         | <i>Fractured Reservoir Modelling</i>               | 2 (2L)        | 4    |
| <b>Elective module 17 – Enhanced Production Engineering</b>                          |  |               |      |
| <b>Elective submodule 17.1</b><br><i>Natural Gas Recovery</i>                        | <i>Enhanced Natural Gas Recovery</i>               | 2 (2L)        | 4    |
| <b>Elective submodule 17.2</b><br><i>Natural Gas Storage</i>                         | <i>Natural Gas Storage</i>                         | 2 (2L)        | 4    |
| <b>Elective submodule 17.3</b><br><i>Enhance Production</i>                          | <i>Enhance production</i>                          | 3 (3L)        | 4    |
| <b>Elective module 18 – Management and Law</b>                                       |  |               |      |
| <b>Elective submodule 18.1</b><br><i>Energy Law</i>                                  | <i>Energy Law II</i>                               | 2 (2L)        | 3    |
| <b>Elective submodule 18.2</b><br><i>Health, Safety and Environmental Management</i> | <i>Health, Safety and Environmental Management</i> | 1 (1L)        | 2    |
| <b>Elective module 19 – Drilling/Production</b>                                      |  |               |      |

|  |  |           |   |
|--|--|-----------|---|
| <b>Elective submodule 19.1</b><br><i>Energy Law</i>                                    | <i>Energy Law II</i>                                 | 2 (2L)    | 3 |
| <b>Elective submodule 19.2</b><br><i>Materials Engineering</i>                         | <i>Materials Engineering and Corrosion</i>           | 2 (2L)    | 3 |
| <b>Elective submodule 19.3</b><br><i>Fluid Mechanics</i>                               | <i>Fluid Mechanics</i>                               | 2 (2L)    | 3 |
| <b>Elective submodule 19.4</b><br><i>Offshore Production and Structures</i>            | <i>Offshore Production and Structures</i>            | 2 (2L)    | 3 |
| <b>Elective submodule 19.5</b><br><i>Numerical Reservoir Simulation</i>                | <i>Numerical Reservoir Simulation</i>                | 3 (2L+1P) | 5 |
| <b>Elective submodule 19.6</b><br><i>Natural Gas Storage</i>                           | <i>Natural Gas Storage</i>                           | 2 (2L)    | 4 |
| <b>Elective submodule 19.7</b><br><i>Geological Modelling</i>                          | <i>Geological Modelling</i>                          | 3 (2L+1P) | 5 |
| <b>Elective submodule 19.8</b><br><i>Applied Well Test Analysis</i>                    | <i>Applied Well Test Analysis</i>                    | 3 (2L+1P) | 5 |
| <b>Elective submodule 19.9</b><br><i>Enhanced Oil Recovery</i>                         | <i>Enhanced Oil Recovery</i>                         | 3 (2L+1P) | 5 |
| <b>Elective module 20 – Deep Geothermal Systems</b>                                    |  |           |   |
| <b>Elective submodule 20.1</b><br><i>Energy Law</i>                                    | <i>Energy Law II</i>                                 | 2 (2L)    | 3 |
| <b>Elective submodule 20.2</b><br><i>Fluid Mechanics</i>                               | <i>Fluid Mechanics</i>                               | 2 (2L)    | 3 |
| <b>Elective submodule 20.3</b><br><i>Numerical Reservoir Simulation</i>                | <i>Numerical Reservoir Simulation</i>                | 3 (2L+1P) | 5 |
| <b>Elective submodule 20.4</b><br><i>Geological Modelling</i>                          | <i>Geological Modelling</i>                          | 3 (2L+1P) | 5 |
| <b>Elective submodule 20.5</b><br><i>Hydrogeology for Geothermal Energy Production</i> | <i>Hydrogeology for Geothermal Energy Production</i> | 1 (1L+1P) | 3 |
| <b>Elective submodule 20.6</b><br><i>Geothermal Geology</i>                            | <i>Geothermal Geology</i>                            | 1 (1L+1P) | 4 |
| <b>Elective submodule 20.7</b><br><i>Fossil &amp; Renewable Energy</i>                 | <i>Fossil &amp; Renewable Energy</i>                 | 3 (2L+1P) | 5 |
| <b>Elective submodule 20.8</b><br><i>Health, Safety and Environmental Management</i>   | <i>Health, Safety and Environmental Management</i>   | 1 (1L)    | 2 |
| <b>Elective submodule 20.9</b><br><i>Geoinformation Systems</i>                        | <i>Geoinformation Systems</i>                        | 3 (2L+1P) | 5 |

**Legend:** L (Lecture), P (Practice), S (Seminars)

According to the data shown in table 4, it can be seen that the student is required to achieve a minimum of 71 ECTS points (59,17% of the total number of points achievable during the course of study) by passing all the mandatory courses which also includes the writing of and defending the thesis. However, regardless of the fact that the students choose the modulee themselves, a part of classes within these modulees are mandatory and others are elective. This means that the overall choice of classes the student is presented with is somewhat limited. The weekly student workload for different forms of lessons, differentiates according to semester and course and varies from 15 to 21 hours per week. Additionally, the workload per semester, displayed in ECTS points, varies from 26 to 34 ECTS accordingly. The student is considered to have successfully passed the study by writing and defending his/her thesis within a time period of 5 months, and the course of the thesis can be chosen after the student achieves at least 80 ECTS points by passing exams during the study.



## 5. UNIVERSITY OF STAVANGER

The first petroleum engineering study program at the University of Stavanger (Kingdom of Norway) was founded in 1977. Today the University of Stavanger, as a part of Faculty of Science and Technology, offers undergraduate, graduate and post-graduate Petroleum Engineering studies. Over 120 employees of various professions participate in the overall performance and organization of classes. The Faculty is divided in two departments: Department of Energy and Petroleum Engineering and Department of Energy Resources. The Petroleum Engineering Graduate Program is conducted in English in its entirety and is two years long, consisting of 4 semesters. The program is free, and to successfully finish the program, students must obtain 120 ECTS points. There is a cap of 30 students per academic year, 10 per each specialization.

Admission requirements for the Graduate Study Program of Petroleum Engineering at the University of Stavanger (<https://www.uis.no/studies/master-s-programmes-in-english/petroleum-engineering/application-and-admission/>):

- ✓ completed undergraduate study of Petroleum Engineering with a minimum duration of three years. Students who have completed other undergraduate programs may enroll in the graduate program of petroleum engineering if they have achieved a minimum of 30 ECTS in courses related to petroleum engineering during their undergraduate study;
- ✓ all candidates must have a minimum of 30 ECTS points in the fields of mathematics and statistics;
- ✓ applicant must have a minimum grade score of 3 according to the ECTS scale or 60% GPA score;
- ✓ applicant must prove competence in English language by having a satisfying score on one of the following standardized tests:
  - ✓ minimum of 80 points on the ETS TOEFL Internet test,
  - ✓ minimum of 550 points on the ETS TOEFL paper delivered test,
  - ✓ minimum score of 6,0 on the IELTS Academic,
  - ✓ minimum 53 points on the PTE (*Pearson Test of English Academic*).

Besides submitting the documents which prove the applicant's fulfillment of prerequisites, students must submit additional documents such as their resume and certified high-school diploma translations. Applicants from outside the EU and the EEA must provide adequate proof they possess at least 10,000.00 EUR in order to finance the one-year study expenses. Table 5 shows the list of courses by semesters and specializations in the Graduate Study Program of Petroleum Engineering, which is conducted in English at the University of Stavanger.

**Table 5.** List of courses by semesters and specializations in the Graduate Study Program of Petroleum Engineering at the University of Stavanger conducted in English (<https://www.uis.no/studies/master-s-programmes-in-english/petroleum-engineering/study-plan-and-course-combination/> )

| SE M.  | COURSE   | MANDATORY/ELECTIVE   | WEEK SCHEDULE | ECTS | NOTE   |  |
|--|--|----------------------|---------------|------|--|--|
| I (winter) semester                                  | <i>PVT of Petroleum Reservoirs and Fluids</i>                                  | mandatory            |               | 10   | Mandatory for all students.  |  |
|  | <i>Directional drilling and Well Flow Engineering</i>                          | mandatory            |               | 10   |  |  |
|  | <i>Computational Reservoir and Well Modeling</i>                               | mandatory            |               | 10   |  |  |
| II (summer) semester                                 | <b>Direction: Drilling and Well Engineering</b>                                |                      |               |      |  |  |
|  | <i>Modern Well Design</i>  | mandatory            |               | 10   | It is not explicitly stated anywhere, but we can conclude that students are able to choose between the recommended elective courses and elective courses which must amount to 30 ECTS points in their study. |  |
|  | <i>Automated Drilling and Modeling</i>   | mandatory            |               | 10   |  |  |
|  | <i>Advanced Well and Drilling Engineering</i>                                  | mandatory            |               | 10   |  |  |
|  | <b>Direction: Reservoir Engineering</b>  |                      |               |      |  |  |
|  | <i>Improved Recovery Methods</i>   | recommended elective |               | 10   |  |  |
|  | <i>Mathematical and Numerical Modeling of Transport Process</i>                | recommended elective |               | 10   |  |  |
|  | <i>Reservoir Chemistry</i>   | recommended elective |               | 10   |  |  |
|  | <i>Integrated Reservoir Management from Seismic Field Development Planning</i> | recommended elective |               | 10   |  |  |
|  | <i>Geostatic Modeling</i>  | elective             |               | 10   |  |  |
|  | <i>Automated Drilling and Modeling</i>   | elective             |               | 10   |  |  |
|  | <b>Direction: Production and Process Engineering</b>                           |                      |               |      |  |  |
|  | <i>Oil and Gas Production</i>  | mandatory            |               | 10   |  |  |
|  | <i>Process Simulation</i>  | mandatory            |               | 10   |  |  |
|  | <i>Oil and Gas Value Chain</i>   | mandatory            |               | 10   |  |  |
| III (winter) semester                                | <b>Direction: Drilling and Well Engineering</b>                                |                      |               |      |  |  |
|  | <i>Subsea Technology</i>   | recommended elective |               | 10   | It is not explicitly stated anywhere, but we can conclude that students are able to choose between the recommended elective courses and elective courses which must amount to 30 ECTS points in their study. |  |
|  | <i>Formation Evaluation</i>  | recommended elective |               | 10   |  |  |
|  | <i>Well Integrity and Permanent Plugging and Abandonment</i>                   | recommended elective |               | 10   |  |  |
|  | <i>Well Completion and Intervention)</i>                                       | recommended elective |               | 10   |  |  |
|  | <i>Reservoir Geomechanics</i>  | elective             |               | 10   |  |  |
|  | <i>Economics and Decision Analysis for Engineers</i>                           | elective             |               | 10   |  |  |
|  | <b>Direction: Reservoir Engineering</b>  |                      |               |      |  |  |
|  | <i>Modeling and Decision Insight</i>   | recommended elective |               | 10   | It is not explicitly stated anywhere, but we can conclude that students are able to choose between the recommended elective courses and elective courses which must amount to 30 ECTS points in their study. |  |
|  | <i>Reservoir Simulation</i>  | recommended elective |               | 10   |  |  |
|  | <i>Formation Evaluation</i>  | recommended elective |               | 10   |  |  |
| <i>Economics and Decision Analysis for Engineers</i> | recommended elective   |                      | 10            |      |  |  |
| <i>Developing Research Skills</i>                    | elective   |                      | 10            |      |  |  |

|                         |   |                      |  |    |  |  |
|-------------------------|---|----------------------|--|----|--|--|
| IV (summer)<br>semester | <i>Reservoir Geomechanics</i>                           | elective             |  | 10 | It is not explicitly stated anywhere, but we can conclude that students are able to choose between the recommended elective courses and elective courses which must amount to 30 ECTS points in their study. |  |
|                         | <b>Direction: Production and Process Engineering</b>    |                      |  |    |  |  |
|                         | <i>Gas Conversion and Oil Refining</i>                  | recommended elective |  | 10 |  |  |
|                         | <i>Oil and Gas Processing and LNG</i>                   | recommended elective |  | 10 |  |  |
|                         | <i>From Gas to Electricity</i>                          | recommended elective |  | 10 |  |  |
|                         | <i>Measurement and Control in Petroleum Engineering</i> | recommended elective |  | 10 |  |  |
|                         | <i>Multiphase flow in Pipes</i>                         | elective             |  | 10 |  |  |
|                         | <i>Economics and Decision Analysis for Engineers</i>    | elective             |  | 10 |  |  |
|                         | <i>Master Thesis</i>                                    |                      |  | 30 |  |  |

Table 5 illustrates that the ratio of ECTS points between mandatory and elective courses is 50:50, when the student chooses his specialization. However, within the specialization there are mandatory, recommended and elective courses, thus narrowing the student's freedom of choice when deciding which courses to enroll in. The graduate study of petroleum engineering at the University of Stavanger ends with the writing and defense of a thesis. What might be useful to point out is the exam format, which is, in majority of cases, a four hour written exam. Although the exact weekly schedule and the delivery format are not specified for each course, in most cases it is a combination of several delivery formats such as lectures, exercises, laboratory visits while the courses also include plenty of independent work through homework and projects.

## 6. NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

*Faculty of Engineering*, a part of the Norwegian University of Science and Technology, conducts undergraduate, graduate and post-graduate petroleum engineering studies. Graduate program, consisting of four semesters, is two years long. It is free for all students regardless of their nationality and conducted in English. To obtain the graduate degree, students must receive 120 ECTS points. The program is carried out by professors from the *Department of Geoscience and Petroleum Engineering* who, besides petroleum engineering also cover the fields of geology and geotechnology. Considering the professors and researchers cover a wide scientific field, they are divided in six groups based on specific scientific fields such as geology, geophysics, reservoir engineering or petrophysics. It should be noted however that the same University, at the *Department of Energy and Process Engineering*, is offering a graduate Natural Gas Technology program in English which focuses on a wide variety of fields from the natural gas transportation to its exploitation in various process.

Admission requirements for the graduate study program of petroleum engineering at the Norwegian University of Science and Technology (<https://www.ntnu.edu/studies/msg1/admission>):

- ✓ completed undergraduate study of petroleum engineering with a minimum duration of three years. Applicants who have completed an undergraduate degree in mechanical engineering or chemical engineering can also apply if they have sufficient work experience in the petroleum industry
- ✓ have a minimum of 30 ECTS points in the fields of mathematics and statistics during their undergraduate study, with a minimum one course in statistics
- ✓ grade C or higher on the ECTS scale during the undergraduate program
- ✓ applicant must prove competence in English language by having a satisfying score on one of the following standardized tests (<https://www.ntnu.edu/studies/langcourses/languagerequirements#EnglishInternationalMaster>):
  - ✓ minimum of 90 on the ETS TOEFL Internet test;
  - ✓ minimum of 600 points on the ETS TOEFL paper delivered test;
  - ✓ minimum score of 6,0 on the IELTS Academic;
  - ✓ 62 points or more - PTE (*Pearson Test of English Academic*);
  - ✓ University of Cambridge certificate.

Besides submitting the documents which prove the applicant's fulfillment of prerequisites, students must submit their resume, motivation letter and documentation which prove special needs if student has any. Applicants from outside the EU and the EEA must

provide adequate proof they possess the ability to finance their living expenses while studying. There are three specialization within the program: reservoir engineering and petrophysics, well drilling and hydrocarbon production. Table 6 shows the list of courses by semesters and specializations in the graduate study program of petroleum engineering, which is conducted in English at the Norwegian University of Science and Technology.

**Table 6.** List of courses by semesters and specializations in the Graduate Study Program of Petroleum Engineering at the Norwegian University of Science and Technology conducted in English

(<https://www.ntnu.edu/studies/plans#programmeCode=MSG1&year=2019&dir=MSG1PE REP19>)

| SE ME.              | COURSE  | MANDATORY/ ELECTIVE | SATNICA                 | ECTS | NOTE   |  |  |
|---------------------|---|---------------------|-------------------------|------|--|--|--|
| I (winter) semester | <i>Reservoir Recovery Techniques</i>                                      | mandatory           | 12<br>(4L+4P+4S<br>PEC) | 7,5  | Mandatory course for all students.   |  |  |
|                     | <i>Applied Computer Methods in Petroleum Science</i>                      | mandatory           | 12<br>(4L+2P+6S<br>PEC) | 7,5  | Mandatory course for all students.   |  |  |
|                     | <b>Direction: Reservoir Engineering and Petrophysics</b>                  |                     |                         |      |  |  |  |
|                     | <i>Reservoir Property Determination by Core Analysis and Well Testing</i> | elective            | 12<br>(4L+2P+6S<br>PEC) | 7,5  | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |  |
|                     | <i>Petrophysics - Well Logging, Fundamentals</i>                          | elective            | 12<br>(4L+2P+6S<br>PEC) | 7,5  |  |  |  |
|                     | <i>Drilling Engineering, Advanced Course 1 - High Deviation Drilling</i>  | elective            | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |  |  |
|                     | <i>Subsurface Decision Analysis</i>                                       | elective            | 12<br>(4L+4P+4S<br>PEC) | 7,5  |  |  |  |
|                     | <i>3D Visualization of Petroleum Data</i>                                 | elective            | 12<br>(2L+3P+7S<br>PEC) | 7,5  |  |  |  |
|                     | <i>3D Visualization of Petroleum Data Production Wells</i>                | elective            | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |  |  |
|                     | <i>CO2 Storage: Operation and Integrity of Engineered CO2 Storage</i>     | elective            | 12<br>(4L+3P+5S<br>PEC) |      |  |  |  |
|                     | <b>Direction: Drilling</b>  |                     |                         |      |  |  |  |
|                     | <i>Drilling Engineering, Advanced Course 1 - High Deviation Drilling</i>  | mandatory           | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |
|                     | <i>Reservoir Property Determination by Core Analysis and Well Testing</i> | elective            | 12<br>(4L+2P+6S<br>PEC) | 7,5  |  |  |  |
|                     | <i>Petrophysics - Well Logging, Fundamentals</i>                          | elective            | 12<br>(4L+2P+6S<br>PEC) | 7,5  |  |  |  |
|                     | <i>Subsurface Decision Analysis</i>                                       | elective            | 12<br>(4L+4P+4S<br>PEC) | 7,5  |  |  |  |
|                     | <i>3D Visualization of Petroleum Data</i>                                 | elective            | 12<br>(2L+3P+7S<br>PEC) | 7,5  |  |  |  |
|                     | <i>3D Visualization of Petroleum Data Production Wells</i>                | elective            | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |  |  |
|                     | <b>Direction: Hydrocarbon Production</b>                                  |                     |                         |      |  |  |  |



|   |   |                         |                         |  |  |   |
|---|---|-------------------------|-------------------------|--|--|---|
|   | <i>3D Visualization of Petroleum Data Production Wells</i>                        | mandatory               | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Reservoir Property Determination by Core Analysis and Well Testing</i>         | elective                | 12<br>(4L+2P+6S<br>PEC) | 7,5  | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |   |
|   | <i>Petrophysics - Well Logging, Fundamentals</i>                                  | elective                | 12<br>(4L+2P+6S<br>PEC) | 7,5  |  |   |
|   | <i>Drilling Engineering, Advanced Course 1 - High Deviation Drilling</i>          | elective                | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Subsurface Decision Analysis</i>   | elective                | 12<br>(4L+4P+4S<br>PEC) | 7,5  |  |   |
|   | <i>3D Visualization of Petroleum Data</i>   | elective                | 12<br>(2L+3P+7S<br>PEC) | 7,5  |  |   |
| <b>Direction: Reservoir Engineering and Petrophysics</b>          |   |                         |                         |  |  |   |
| II (summer) semester  | <i>Reservoir Fluids and Flow</i>  | mandatory               | 12<br>(4L+6P+2S<br>PEC) | 7,5  |  |   |
|   | <i>Reservoir Simulation</i>   | mandatory               | 12<br>(4L+4P+4S<br>PEC) | 7,5  |  |   |
|   | <i>Petrophysics, Interpretation of Well Data, Advanced Course</i>                 | elective                | 12<br>(4L+2P+6S<br>PEC) | 7,5  | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |   |
|   | <i>Subsea Technology</i>  | elective                | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Field Development and Operations</i>   | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Drilling Engineering, Advanced Course 2 – Wellbore Stability and Integrity</i> | elective                | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Petroleum Economics</i>  | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  |  |   |
|   | <i>Elective – selection of one course in interdisciplinary area</i>               | mandatory               |                         | 7,5  |  | Unfortunately, it is not indicated anywhere whether this course that amounts to 7.5 ECTS points carries in the ECTS total per semester. |
|   | <b>Direction: Drilling</b>  |                         |                         |  |  |   |
|   | <i>Drilling Engineering, Advanced Course 2 – Wellbore Stability and Integrity</i> | mandatory               | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |   |
| <i>Reservoir Fluids and Flow</i>                                  | elective  | 12<br>(4L+6P+2S<br>PEC) | 7,5                     | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |   |
| <i>Reservoir Stimulation</i>                                      | elective  | 12<br>(4L+4P+4S<br>PEC) | 7,5                     |  |  |   |
| <i>Petrophysics, Interpretation of Well Data, Advanced Course</i> | elective  | 12<br>(4L+2P+6S<br>PEC) | 7,5                     |  |  |   |
| <i>Subsea Technology</i>  | elective  | 12<br>(4L+1P+7S<br>PEC) | 7,5                     |  |  |   |

|   |   |                         |                         |  |  |  |
|---|---|-------------------------|-------------------------|--|--|--|
| III (winter semester)   | <i>Field Development and Operations</i>   | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  | Unfortunately, it is not indicated anywhere whether this course carries in the 7,5 ECTS points per semester.   |  |
|   | <i>Petroleum Economics</i>  | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  |  |  |
|   | <i>Elective – one course in interdisciplinary area</i>                            | mandatory               |                         | 7,5  |  |  |
|   | <b>Direction: Hydrocarbon Production</b>  |                         |                         |  |  |  |
|   | <i>Reservoir Fluids and Flow</i>  | mandatory               | 12<br>(4L+6P+2S<br>PEC) | 7,5  | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |
|   | <i>Field Development and Operation</i>  | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  |  |  |
|   |   | elective                | 12<br>(4L+4P+4S<br>PEC) | 7,5  |  |  |
|   | <i>Petrophysics, Interpretation of Well Data, Advanced Course</i>                 | elective                | 12<br>(4L+2P+6S<br>PEC) | 7,5  |  |  |
|   | <i>Subsea Technology</i>  | elective                | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |  |
|   | <i>Drilling Engineering, Advanced Course 2 – Wellbore Stability and Integrity</i> | elective                | 12<br>(4L+1P+7S<br>PEC) | 7,5  |  |  |
|   | <i>Petroleum Economics</i>  | elective                | 12<br>(3L+2P+7S<br>PEC) | 7,5  |  |  |
|   | <i>Elective – one course in interdisciplinary area</i>                            | mandatory               |                         | 7,5  | Unfortunately, it is not indicated anywhere whether this course amounts to 7,5 ECTS points carries in the ECTS total per semester.   |  |
|   | <i>Petroleum Engineering, Specialization Project</i>                              | mandatory               | 24<br>(24SPEC)          | 15   |  |  |
|   | <i>Petroleum Engineering, Specialization Course</i>                               | mandatory               | 24<br>(24SPEC)          | 7,5  | Unfortunately, it is not indicated anywhere whether this course amounts to 7,5 ECTS points carries in the ECTS total per semester.   |  |
|   | <b>Direction: Reservoir Engineering and Petrophysics</b>                          |                         |                         |  |  |  |
| <i>Formation Mechanics</i>  | elective  | 12<br>(3L+3P+3S<br>PEC) | 7,5                     | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |  |
| <i>Reservoir Property Determination by Core Analysis and Well Testing</i> | elective  | 12<br>(4L+2P+6S<br>PEC) | 7,5                     |  |  |  |
| <i>3D Visualization of Petroleum Data</i>                                 | elective  | 12<br>(2L+3P+7S<br>PEC) | 7,5                     |  |  |  |



|                      |  |          |                         |     |  |  |
|----------------------|--|----------|-------------------------|-----|--|--|
| IV (summer) semester | <i>Petrophysics - Well Logging, Fundamentals</i>                         | elective | 12<br>(4L+2P+6S<br>PEC) | 7,5 | Even though it is not explicitly stated anywhere, we can conclude that students are able to choose between two of the offered elective courses, which when combined with the mandatory courses amounts to 30 ECTS points per semester. |  |
|                      | <i>Drilling Engineering, Advanced Course 1 - High Deviation Drilling</i> | elective | 12<br>(4L+1P+7S<br>PEC) | 7,5 |  |  |
|                      | <i>3D Visualization of Petroleum Data Production Wells</i>               | elective | 12<br>(4L+1P+7S<br>PEC) | 7,5 |  |  |
|                      | <b>Direction: Drilling</b>   |          |                         |     |  |  |
|                      | <i>3D Visualization of Petroleum Data</i>                                | elective | 12<br>(2L+3P+7S<br>PEC) | 7,5 |  |  |
|                      | <i>Formation Mechanics</i>   | elective | 12<br>(3L+3P+3S<br>PEC) | 7,5 |  |  |
|                      | <i>3D Visualization of Petroleum Data Production Wells</i>               | elective | 12<br>(4L+1P+7S<br>PEC) | 7,5 |  |  |
|                      | <b>Direction: Hydrocarbon Production</b>                                 |          |                         |     |  |  |
|                      | <i>Formation Mechanics</i>   | elective | 12<br>(3L+3P+3S<br>PEC) | 7,5 |  |  |
|                      | <i>3D Visualization of Petroleum Data</i>                                | elective | 12<br>(2L+3P+7S<br>PEC) | 7,5 |  |  |
|                      | <i>Drilling Engineering, Advanced Course 1 - High Deviation Drilling</i> | elective | 12<br>(4L+1P+7S<br>PEC) | 7,5 |  |  |
|                      | <i>Master Thesis</i>   |          |                         | 30  |  |  |

**Legend:** L (Lecture), P (Practice), SPEC (Specialization)

Table 6 illustrates that the majority of elective courses are repeated depending on the semester, specialization and the year of study. However, only a small portion of elective courses has a clearly defined lecturing and exam schedule. Therefore, the choice of elective courses greatly depends on the schedule of all other courses. Due to this reason, a large number of courses is repeated in the final year of education so they can be enrolled in by students who, due to scheduling issues, were not able to do so in the earlier years. When comparing the ratio of elective and mandatory courses, 31,25% of ECTS points come from elective courses. However, when taking into consideration the fact that the specialization itself is elective in nature, then the percentage of elective courses rises to 43,75% of total ECTS points awarded by the program.

## 7. DELFT UNIVERSITY OF TECHNOLOGY – TU DELFT

*Faculty of Civil Engineering and Geosciences*, a part of the Delft University of Technology, conducts undergraduate, graduate and post-graduate petroleum engineering studies. Lecturing and research is conducted by 18 professors and 18 PhD candidates who are part of the Department of Geosciences and Engineering. Research efforts in the field of petroleum engineering are divided in three fields: fluid flow through rock, advanced reservoir simulation and optimization, and geothermal engineering.

Graduate program, since 2019/2020 academic year known as Msc Track: Geo-Energy Engineering, consists of four semesters, is two years long and conducted in English. To obtain the graduate degree, student must receive 120 ECTS points. According to the available data on the University's website, international students make up 41% of student body (<https://www.tudelft.nl/en/education/programmes/masters/applied-earth-sciences/msc-applied-earth-sciences/msc-programme/track-geo-energy-engineering/>). For non-EU nationals, tuition fee is 18.750,00 EUR, while EU national's tuition is 2.143,00 EUR.

Admission Requirements for graduate study in Geo-energy engineering enrolment at Delft University of Technology conducted in English (<https://www.tudelft.nl/en/education/admission-and-application/msc-international-diploma/admission-requirements/>):

- ✓ The degree must be closely related to graduate programme of choice.
- ✓ A bachelor's degree with a Cumulative Grade Point Average (CGPA) of at least 75% of the scale maximum, unless specific requirements are defined.
- ✓ applicant must prove competence in English language by having a satisfying score on one of the following standardized tests:
  - ✓ A TOEFL iBT with an overall band score of at least 90 and a minimum score of 21 for each section. TOEFL MyBest scores not accepted, the required scores should be obtained in one single test;
  - ✓ 600 points or more - ETS TOEFL paper delivered test;
  - ✓ An IELTS (academic version) with an overall Band score of at least 6.5 and a minimum of 6.0 for each section;
  - ✓ Cambridge Assessment English certificate:
    - ✓ C1 Advanced (Certificate of Advanced English) with an overall score of 176 and a minimum of 169 for each section;
    - ✓ C2 Proficiency (Certificate of Proficiency in English) with an overall score of 180 and a minimum of 169 for each section.

Besides submitting the documents which prove the applicant's fulfillment of prerequisites, students must submit their resume and a motivation letter which also contains a description of the potential project student would undertake during their study.



The geo-energy engineering program aims to provide basics for each student in the field of geo-energy and its modern-day use, energy transition, geology, physics and modeling. After completing the basics, students further specialize by choosing elective courses of their choice, out of which most are related to the field of reservoir engineering. Table 7 shows the list of courses and their ECTS value in the graduate study program of geo-energy engineering, which is conducted in English at the Delft University of Technology.

**Table 7.** List of courses and their ECTS value in the graduate study program of geo-energy engineering, conducted in English at the Delft University of Technology ([https://studiegids.tudelft.nl/a101\\_displayProgram.do?program\\_tree\\_id=23238](https://studiegids.tudelft.nl/a101_displayProgram.do?program_tree_id=23238))

| GOD  | COURSE  | MANDATORY/<br>ELECTIVE | WEEK<br>SCHEDULE | ECTS | NOTE  |  |
|--|---|------------------------|------------------|------|---|--|
| I. year  | <i>Geo-Energy Engineering Challenge</i>                       | mandatory              | 21 (5P+16V)      | 12   |   |  |
|  | <i>Energy Transition</i>                                      | mandatory              | 3 (2P+1V)        | 3    |   |  |
|  | <i>Geology for Geo-Energy</i>                                 | mandatory              | 6 (3P+3V)        | 5    |   |  |
|  | <i>Physics for Geosystems</i>                                 | mandatory              | 6 (3P+3V)        | 5    |   |  |
|  | <i>Forward and Inverse Geomodelling</i>                       | mandatory              | 6 (3P+3V)        | 5    |   |  |
|  | <i>Field Lab</i>  | mandatory              | 26 (4P+22V)      | 15   |   |  |
|  | <b>Group of elective courses 1</b>                            |                        |                  |      |   |  |
|  | <i>Geothermal Energy</i>                                      | elective               | 3 (2P+1V)        | 3    | All students must enroll in a minimum of two out of four elective courses from Group 1 of elective courses. |  |
|  | <i>Petroleum Exploration and Production</i>                   | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Subsurface Storage</i>                                     | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Effects of Subsurface Engineering</i>                      | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <b>Group of elective courses 2</b>                            |                        |                  |      |   |  |
|  | <i>Advanced Sedimentary Geology</i>                           | elective               | 3 (2P+1V)        | 3    | All students must enroll in a minimum of two out of four elective courses from Group 2 of elective courses. |  |
|  | <i>Geomechanics and Structural Geology</i>                    | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Simulation and Building of Stratigraphy</i>                | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Production Science and Technology</i>                      | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <b>Group of elective courses 3</b>                            |                        |                  |      |   |  |
|  | <i>Multiphase Flow in Porous Rock</i>                         | elective               | 3 (2P+1V)        | 3    | All students must enroll in a minimum of two out of four elective courses from Group 3 of elective courses. |  |
|  | <i>Dynamic Modeling and Optimization</i>                      | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Geophysical Prospecting</i>                                | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <i>Numerical Methods for Subsurface Geoscience Simulation</i> | elective               | 3 (2P+1V)        | 3    |   |  |
|  | <b>Group of elective courses 4</b>                            |                        |                  |      |   |  |
|  | <i>Reservoir Characterization and Petrophysics</i>            | elective               | 3 (2P+1V)        | 3    | All students must enroll in a minimum of two out of four elective courses from Group 4 of elective courses. |  |
|  | <i>Geologic Interpretation of Geophysical Data</i>            | elective               | 3 (2P+1V)        | 3    |   |  |
| <i>Outcrop Geology for Subsurface Characterization</i> | elective  | 3 (2P+1V)              | 3                |      |   |  |
| I I  | <i>Geo-Energy Engineering Project</i>                         | mandatory              |                  | 15   |   |  |

|  |                      |           |  |    |  |
|--|----------------------|-----------|--|----|--|
|  |                      |           |  |    |  |
|  | <i>Master thesis</i> | mandatory |  | 45 |  |

**Legend:** **L** (Lecture), **P** (Practice)

The program is not divided in semesters. Academic year is divided in periods of 10 weeks, and accordingly, the lectures are sequential in nature with the possibility of activities related to individual courses partially overlapping. Unlike other graduate courses presented so far, the whole second year contains of only two activities – the final project and its defense, which is held in public. Table 7 illustrates that elective courses can be chosen up to 15 ECTS points only in the first year of study. Therefore only 12,5% of total ECTS points students must achieve in the program come from elective courses.

## 8. POLYTECHNIC UNIVERSITY OF TURIN

Polytechnic University of Turin (*Politecnico di Torino*) conducts a graduate program in petroleum and mining engineering in English, as well as a specializing graduate programme in energy production and using in English delivered in co-operation with ENI. The latter will not be considered because it is a specialist graduate study program with a total workload of 80 ECTS points. Graduate program in petroleum and mining engineering, consisting of four semesters has a total workload of 120 ECTS points. Tuition is paid by all students, and the fee varies from 160 to 2.600,00 EUR for EU nationals, and from 160 to 3.000,00 EUR for non-EU nationals, depending on the economic vulnerability of the country. The program is carried out by 18 professors who are all part of the *Department of Environment, Land and Infrastructure Engineering*.

Admission requirements for Graduate Study in Petroleum Engineering enrolment at Polytechnic University of Turin conducted in English:

- ✓ undergraduate degree,
- ✓ applicant must prove competence in English language by having a satisfying score on one of the following standardized tests:
  - ✓ 5,5 score or more - IELTS Academic or an equally valuable confirmation from related internationally recognized test ([https://didattica.polito.it/zxd/dati/allegato/17/TABELLA\\_INGLESE\\_2017\\_18V\\_4\\_ENG.pdf](https://didattica.polito.it/zxd/dati/allegato/17/TABELLA_INGLESE_2017_18V_4_ENG.pdf)).

Table 8 shows the list of courses and their ECTS value in the Graduate Study Program of Petroleum and Mining Engineering at the Polytechnic University of Turin conducted in English.

**Table 8.** List of courses and their ECTS value in the Graduate Study Program of Petroleum and Mining Engineering, at the Polytechnic University of Turin conducted in English ([https://didattica.polito.it/pls/portal30/sviluppo.offerta\\_formativa\\_2019.vis?p\\_coorte=2020&p\\_sdu=32&p\\_cds=10](https://didattica.polito.it/pls/portal30/sviluppo.offerta_formativa_2019.vis?p_coorte=2020&p_sdu=32&p_cds=10))

| SEM EST ER          | COURSE  | MANDAT ORY/ELE CTIVE | UKUPNA SATNICA PO PREDMETU | ECTS | NOTE |
|---------------------|---|----------------------|----------------------------|------|------|
| I (winter) semester | <i>Fluid Mechanics in Porous Media</i>            | mandatory            | 120 (80L+20P+20INS)        | 10   |      |
|                     | <i>Petroleum and Mining Geology</i>               | mandatory            | 140 (80L+20P+40INS)        | 10   |      |
|                     | <i>Petroleum Technology</i>                       | mandatory            | 60 (48L+12P)               | 6    |      |
|                     | <i>Resources and Environmental Sustainability</i> | mandatory            | 80 (71L+9P)                | 8    |      |
|                     | <i>Exploration Geophysics</i>                     | mandatory            | 80 (50L+12P+18L)           | 8    |      |

|                       |   |           |                     |    |  |
|-----------------------|---|-----------|---------------------|----|--|
| II (summer) semester  | <i>Risk Analysis</i>  | mandatory | 115 (63L+37P+15INS) | 10 |  |
|                       | <i>Structural Mechanics</i>                                   | mandatory | 60 (40L+20P)        | 6  |  |
|                       | <i>Reservoir Geomechanics</i>                                 | mandatory | 60 (40L+20P)        | 6  |  |
| III (winter) semester | <i>Oil and mining contaminations in soils and groundwater</i> | mandatory | 60 (40L+20P)        | 6  |  |
|                       | <i>Reservoir Engineering</i>                                  | mandatory | 120 (100L+20P)      | 12 |  |
|                       | <i>Well Drilling and Completion</i>                           | mandatory | 100 (80L+20P)       | 10 |  |
|                       | <i>Oil and Gas Production and Transport</i>                   | elective  | 60 (48L+12P)        | 6  | The elective courses chosen by each student must amount to 12 ECTS points. |
| IV (summer) semester  | <i>Environmental Spatial Analysis</i>                         | elective  | 60 (30L+30P)        | 6  |  |
|                       | <i>Models and Scenarios for Energy Planning</i>               | elective  |                     | 6  |  |
|                       | <i>Professional Training</i>                                  | elective  | 150                 | 6  |  |
|                       | <i>Well Logging and Testing</i>                               | elective  | 60 (40L+20P)        | 6  |  |
|                       | <i>Master Thesis</i>  | mandatory |                     | 16 |  |

**Legend:** L (Lecture), P (Practice), L (Lab), INS (Instructions)

Table 8 illustrates that 108 out of 120 ECTS points are mandatory, while only 12 ECTS points, or 10%, come from elective courses.



## 9. UNIVERSITY OF ABERDEEN

The Faculty of Engineering is considered as a core part of the Aberdeen University and offers study programmes in the fields of Petroleum Engineering on undergraduate, graduate and post graduate levels. Since the University is located in Great Britain, all study programmes are conducted in English. At the graduate level, the students may choose the 12 month or 24 months duration graduate study programme of Petroleum Engineering either as full time or as part time students, as well as the 12 months duration graduate study programme of oil and gas engineering but only for full time students. In addition to the aforementioned study programmes, there are a few programmes in the multidisciplinary fields such as; Managing Oil and Gas Companies, Energetics etc. Both study programmes offer the possibility of remote study for part-time students. The fees of studying depend on the study programme in which the students enroll. The yearly tuition for the 24 months Graduate Study Programme of Petroleum Engineering totals 9.000,00 £ for students from the UK and the European Union and 23.000,00 £ for other foreign students. The classes for the field of oil engineering are currently lectured by 11 educators.

### *Graduate Study Programme of Petroleum Engineering*

Enrollment prerequisites for the Programme of Petroleum Engineering at the University of Aberdeen (<https://www.abdn.ac.uk/study/postgraduate-taught/degree-programmes/222/petroleum-engineering/>) :

- ✓ bachelor's degree of engineering or applied mathematics with the minimum grade of 2:1 with accordance to the UK grading system which corresponds to the grades of A-, B and B+ for the ECTS grading scale;
- ✓ bachelor's degree of engineering or applied mathematics with the minimum grade of 2:2 with accordance to the UK grading system which corresponds to the grades of B, B- and C for the ECTS grading scale, along with the condition that the entrant has a minimum of 2 years of relevant work experience;
- ✓ bachelor's degree in the field of geology, physics or chemistry with the minimum grade of 2:1 with accordance to the UK grading system which corresponds to the grades of A-, B and B+ for the ECTS grading scale, along with the condition that the entrant has a minimum of 2 years of relevant work experience;
- ✓ the completed study programme must incorporate subjects from the fields of mathematics and physics;
- ✓ knowledge of the English language which is demonstrated by achieving one of the following results at one of the internationally acknowledged exam:
  - o minimum grade of 6,5 for the IELTS academic exam,



- o minimum of 90 points for the TOEFL iBT exam,
- o minimum of 62 points for the PTE academic exam,
- o minimum of 176 points for the testing carried out by the exam of the University of Cambridge (*Cambridge English Advanced & Proficiency*).

In addition to the documents proving the afore mentioned fulfilment of criteria for enrollment at the Graduate Study of Petroleum Engineering, entrants must also submit their resume and motivational letter. Table 9 demonstrates the courses with the associated number of ECTS points at the Graduate Study of Petroleum Engineering at the University of Aberdeen.

**Table 9.** List of courses and their ECTS value at the Graduate Study Program of Petroleum Engineering at the University of Aberdeen (<https://www.abdn.ac.uk/study/postgraduate-taught/degree-programmes/222/petroleum-engineering/>)

| SEM.                  | COURSE  | MANDATORY/ELECTIVE | ECTS | NOTE |
|-----------------------|---|--------------------|------|------|
| I (winter) semester   | <i>Fundamentals of Petroleum Geoscience</i>                 | mandatory          | 7,5  |      |
|                       | <i>Petrophysics, Core Analysis and Formation Evaluation</i> | mandatory          | 7,5  |      |
|                       | <i>Reservoir Engineering</i>                                | mandatory          | 7,5  |      |
|                       | <i>Well and Production Engineering</i>                      | mandatory          | 7,5  |      |
| II (summer) semester  | <i>Reservoir Simulation</i>                                 | mandatory          | 7,5  |      |
|                       | <i>Well Testing: Analysis and Design</i>                    | mandatory          | 7,5  |      |
|                       | <i>Field Development and Petroleum Economics</i>            | mandatory          | 7,5  |      |
|                       | <i>Enhanced Oil Recovery</i>                                | mandatory          | 7,5  |      |
| III (winter) semester | <i>Individual Project in Petroleum Engineering</i>          | mandatory          | 30   |      |

With the completion of the Graduate Study Programme of Petroleum Engineering, the student acquires a total of 90 ECTS points. During the course of the study, the student does not have the option of selective courses. Note that the Undergraduate Study of Petroleum Engineering at the same university has a total duration of 4 years, which means that the 3 semester – 90 ECTS of graduate study is the logical continuation of the undergraduate study.

### *Graduate Study of Oil and Gas Engineering*

Enrollment prerequisites for the Graduate Study Programme of Oil and Gas Engineering at the University of Aberdeen (<https://www.abdn.ac.uk/study/postgraduate-taught/degree-programmes/210/oil-and-gas-engineering/>) :

- ✓ bachelor's degree of engineering or physics with the minimum grade of 2:1 with accordance to the UK grading system which corresponds to the grades of A-, B and B+ for the ECTS grading scale;
- ✓ bachelor's degree of engineering with the minimum grade of 2:2 with accordance to the UK grading system which corresponds to the grades of B, Band C for the ECTS grading scale, along with the condition that the entrant has a minimum of 2 years of relevant work experience in the oil and gas industry;
- ✓ the completed study programme must incorporate subjects from the field of mathematics;
- ✓ knowledge of the English language which is demonstrated by achieving one of the following results at one of the internationally acknowledged exams:
  - minimum grade of 6,5 for the IELTS academic exam,
  - minimum of 90 points for the TOEFL iBT exam,
  - minimum of 62 points for the PTE academic exam,
  - minimum of 176 points for the testing carried out by the exam of the University of Cambridge (*Cambridge English Advanced & Proficiency*).

In addition to the documents proving the afore mentioned fulfilment of criteria for enrollment at the graduate study of petroleum engineering, entrants must also submit their resume and motivational letter. Table 10 demonstrates the courses with the associated number of ECTS points at the Graduate Study of Oil and Gas Engineering at the University of Aberdeen.

**Table 10.** List of courses and their ECTS value in the Graduate Study Programme of Oil and Gas Engineering at the University of Aberdeen

| SEM.                 | COURSE   | MANDATORY/ELECTIVE | ECTS | NOTE |
|----------------------|--|--------------------|------|------|
| I (winter) semester  | <i>Reservoir Engineering</i>                                       | mandatory          | 7,5  |      |
|                      | <i>Fundamental Safety Engineering and Risk Management Concepts</i> | mandatory          | 7,5  |      |
|                      | <i>Fundamentals of Petroleum Geoscience</i>                        | mandatory          | 7,5  |      |
|                      | <i>Project Management</i>  | mandatory          | 7,5  |      |
| II (summer) semester | <i>Facilities Engineering</i>                                      | mandatory          | 7,5  |      |
|                      | <i>Flow Assurance</i>  | mandatory          | 7,5  |      |

|                          |  |           |     |  |
|--------------------------|--|-----------|-----|--|
|                          | <i>Oil and Gas Chemistry</i>                       | mandatory | 7,5 |  |
|                          | <i>Well and Production Engineering</i>             | mandatory | 7,5 |  |
| III (winter)<br>semester | <i>Individual Project in Petroleum Engineering</i> | mandatory | 30  |  |

## 10. GRADUATE PETROLEUM ENGINEERING PROGRAMME COMPARISON IN EUROPEAN HIGHER EDUCATION

The cumulative overview of relevant data about accredited graduate study programmes of petroleum engineering in the European area of higher education which are conducted in English is provided in supplement A. Based on this data the following can be concluded:

- ✓ All considered universities, except those in Great Britain, have a graduate study organised as a 2 year study programme (4 semesters) with a total of 120 ECTS.
- ✓ The price of the scholarships at the considered study programmes depends on the university itself. The range can vary from study programmes like those implemented by the Universities of Leoben and Stavanger as well as the Norwegian University for Science and Technology which are completely free, to programmes which cost 23.000,00 £ per year such as the Graduate study programme for petroleum engineering or Graduate study programme for petroleum and gas engineering at the University of Aberdeen. Furthermore, it is important to mention that at certain university, the tuition fee depends on the students performance.
- ✓ Out of the 10 considered study programmes, 4 of them offer the possibility of choosing a modulee or specialization during study, while the university in Clausthal offers the possibility for students to not only choose the specialization but courses within the modulee as well. Specializations or modulees are most often related to the following four courses: wells drilling and completion; hydrocarbon production and transportation, reservoir engineering and exploitation of geothermal energy. Some universities, such as the Technical University of Delft offer the possibility of specialization by choosing specific elective courses.
- ✓ Finished undergraduate study of petroleum engineering is considered as a requirement for most universities. However, some universities allow enrollment of students who completed a different type of undergraduate engineering programme such as mechanical engineering or chemical engineering. In addition to the completion of a specific undergraduate study programme, a lot of the universities put emphasis on either the grade accomplished at the undergraduate study, as a prerequisite for enrollment at the graduate study programme of petroleum engineering, or having a specific number of ECTS points from specific areas such as math, statistics, etc.
- ✓ Since the programmes are taught in English, the knowledge of the English language is a core necessity for enrollment at all universities. With regards to this, all universities require the entrees to demonstrate their knowledge of the English language by achieving a certain amount of points at one of the internationally accepted exams such as TOEFL, IELTS and others.
- ✓ The share of electives in study programs varies from university to university. For example, in the considered graduate study programs at the University of Aberdeen or in the Joint international graduate study of Petroleum

Engineering at the University of Leoben and Gubkin State University, elective courses are not foreseen. The highest level of electives can be achieved in graduate study programs that have predefined courses and modules. However, caution is advised here because some study programs such as the International graduate study program in Petroleum Engineering at the University of Leoben allows the student to individually choose their desired modules, but then is required to enrol in all elective classes within the chosen module. In this way, the student has a perceived ability to choose his own courses for anywhere between 36,67 to 39,17% ECTS points throughout course of their study. On the other hand, in some study programs such as the one in the University of Stavanger, the student chooses a course direction that accounts for 50% of his ECTS points (out of the total number of ECTS points provided in the study program), but also has the option of choosing his own elective courses within his specialization, because courses are divided into mandatory courses within their specialization, recommended elective courses and elective courses.

- ✓ All reviewed graduate study programs end the study by writing and defending a master thesis. In addition, the University of Leoben and Miskolc students are required to pass a final exam. The number of ECTS points required for writing and defending the final thesis varies from university to university, ranges anywhere between 16 to 45 ECTS points.
- ✓ Out of all reviewed universities and graduate study programs only the University in Miskolc requires as a condition of completing the degree, a four-week internship or four weeks of work experience in the field of study.