1. Annotation

Course Description

The course is an introduction to Petroleum Engineering and gives an overview of Petroleum Engineering and its various components and their internal connection. The course will address the story of oil from its origin to the end user. The objective is to provide an overview of the fundamental operations in exploration, drilling, production, processing, transportation, and refining of oil and gas. As additional topics it is planned to consider Permafrost Engineering and Flow Assurance, which are actual for Russian Oil&Gas Industry. Within the framework of the course it is planned to invite speakers from industry.

Course Prerequisites

No prerequisites required

2. Structure and Content

Course Academic Level

Master-level
<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of Topic</th>
<th>Lectures (# of hours)</th>
<th>Seminars (# of hours)</th>
<th>Labs (# of hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Petroleum Engineering</td>
<td>Acquaintance with the basic concepts (oil, rock, reservoir, fluid, etc.). The history of the oil and gas industry. Modern global energy demands. Environmental aspects.</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Geology and Petrophysics</td>
<td>Modern understanding of geological structure. Stratigraphy. The main lithological types of rocks. Petrophysics.</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Drilling</td>
<td>The scheme of drilling. The main stages of drilling operation. The design of the rig. Vertical drilling. Horizontal drilling. Visiting Skoltech Hydrocarbone Recovery Lab.</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Geophysics and Well Logging</td>
<td>The main geophysical methods applied in oil and gas industry. Methods and approaches to data interpretation. Well logging. Petroleum Geophysics.</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>The main parameters of hydrocarbons production. Methods of production. EOR. Hydraulic fracturing of rocks. Visiting Skoltech Hydrocarbone Recovery Lab.</td>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Reservoir Engineering</td>
<td>Simulation of reservoir behavior during production. The main parameters of the reservoir. Special accent to Basin Modeling.</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

3. Assignments
<table>
<thead>
<tr>
<th>Assignment Type</th>
<th>Assignment Summary</th>
</tr>
</thead>
</table>
| Essay           | Answer only two questions (short answers, total not more 2 pages, 500 word for each question)  
1. How does fossil fuels contribute to global warming?  
2. What is wrong with global warming? Hasn’t global warming happened before? If yes, why the world is so concerned?  
3. How does the nature cope with global warming? How did it cope in the past?  
4. What can we do to address global warming?  
5. Can you think of innovations that can reduce global warming? |
| Other           | You should:  
1) Find out minimal and maximal possible porosity values for sedimentary rocks.  
2) Investigate permeability value: its derivation, physical meaning and unit of measurement. |
| Essay           | Prepare an essay (not less than 1000 words) about Drilling practices in Russia (Rigs used, Site preparation, Conductor pipe, Casings used, Cementing, Wellhead, How to cope with extreme low temperatures?) |
| Problem Set     | 1) Explain the measurement principles and the petrophysical properties derived from the measurements for the following well logging tools  
1- Caliper  
2- Spontaneous potential (SP)  
3- Gamma ray  
4- Density (Nuclear)  
5- Neutron  
6- Resistivity (Dual Laterolog)  
2) We logged a thick sand reservoir with the previous logging measurements  
- How can I check the quality of the interpreted measurements?  
- How can I differentiate a clean sand reservoir from a shaly sand reservoir?  
- Is it possible to locate the aquifer, the oil and gas zones in the sand reservoir? Do we need more measurements?  
- If the sand reservoir is clean and homogeneous with a porosity of 20%, the aquifer zone has a resistivity of 10 Ohm.m and the hydrocarbon zone has a resistivity of 100 Ohm.m. Is it possible to estimate the water and oil saturation in the oil zone? If not, why? |
| Essay           | Prepare essay (not less than 500 words) about Completion and Production Technologies in Russia.  
The follow topics can help you: Downhole completion (open hole, cased hole, perforations), tubings used, artificial lift technology, sand exclusion practices, hydraulic/acid fracturing, challenges |
| Essay           | Prepare an essay (not less than 500 words) about Methods of methane recovery from gas hydrate reservoirs. |

### 4. Grading

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Activity weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Assignments</td>
<td>20</td>
</tr>
<tr>
<td>Final Project</td>
<td>40</td>
</tr>
</tbody>
</table>
Grading Scale

A: 86
B: 76
C: 66
D: 56
E: 46
F: 0

Attendance Requirements
Mandatory with Exceptions

5. Basic Information

Maximum Number of Students

<table>
<thead>
<tr>
<th></th>
<th>Maximum Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall:</td>
<td>20</td>
</tr>
<tr>
<td>Per Group (for seminars and labs):</td>
<td>5</td>
</tr>
</tbody>
</table>

Course Stream
Science, Technology and Engineering (STE)

Course Term (in context of Academic Year)
- Term 1B (last four weeks)
- Term 2

Course Delivery Frequency
Every year

Students of Which Programs do You Recommend to Consider this Course as an Elective?

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum Engineering</td>
<td></td>
</tr>
</tbody>
</table>

Course Tags
Engineering

6. Textbooks and Internet Resources
### Required Textbooks


### Recommended Textbooks

|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 7. Facilities

#### Equipment

- Whiteboard/Flipchart
- Projector

#### Software

- Microsoft Office

#### Labs for Education

- Hydrocarbon Recovery Laboratory (TPOC3: 047)

### 8. Learning Outcomes

#### Knowledge

- Acquainted with the main aspects of Petroleum Engineering.
- Introduction to the basic methods and approaches used in oil and gas engineering.
- Inter-relation among various aspects with respect to reservoir, fluid, well and processing design.
- Base knowledge about permafrost, gas hydrates and flow assurance.
### Skill

| Create and verify conceptual model of reservoirs through reservoir geology. |
| Select most efficient drilling technologies. |
| Forecast reservoir production based on fluid, reservoir properties and wellbore design. |
| Generate reserves estimates (and associated uncertainties) for use in financial reporting by reservoir engineering. |
| Identify various flow assurance challenges and the most important factors. |
| Ability to make oral and written presentations. |

### Experience

| Ability to work with research literature on oil and gas engineering. |

### 9. Assessment Criteria

**Input or Upload Example(s) of Assignment 1:**

**Select Assignment 1 Type**  
Essay

**Assessment Criteria for Assignment 1**  
Essay evaluation criteria (max 10 points):
1) Content / Development;
2) Organization;
3) Research (Analise);
4) Style;
5) Resources;
6) Timelines (total mark reducing for after deadline submission)
7) Plagiarism (total mark reducing for "copy"-"past"

**Input or Upload Example(s) of Assignment 2:**

**Select Assignment 2 Type**  
Other

**Input or Upload Example(s) of Assignment 3:**

**Select Assignment 3 Type**  
Essay

**Assessment Criteria for Assignment 3**  
Essay evaluation criteria (max 10 points):
1) Content / Development;
2) Organization;
3) Research (Analise);
4) Style;
5) Resources;
6) Timelines (total mark reducing for after deadline submission)
7) Plagiarism (total mark reducing for "copy"-"past"

**Input or Upload Example(s) of Assignment 4:**

**Select Assignment 4 Type**  
Problem Set
Part 1
1. Caliper log
The caliper log is a tool that measures continuously the size (diameter) and shape of a borehole along its depth. This information can help the drilling engineer know the condition of the well bore and the degree of hole stability of the mud system.

The caliper tool can have 2, 4 or more arms, which can move in and out as the tool is withdrawn into the borehole. This movement of its arms is converted to electric signals through the use of a potentiometer.

The one- and two- armed calipers are often used to measure the maximum borehole diameter where a hole is not circular. The four- and six- armed calipers can measure the hole size and shape and is suited for elliptical shaped boreholes.

The caliper logs can be used for the following:
1. Provide information for lithological assessment
2. Indicate porosity zones and good permeability
3. Measurement of borehole volume and required cement volume

2. Spontaneous potential
The spontaneous potential otherwise known as ‘S.P.’ is one of the earliest form of logging measurement. The SP log is a record of the spontaneous potential difference vs depth between an electrode which is placed in the well and is moveable and another electrode, which is at the surface and is fixed. These spontaneous readings is caused by the difference in the salinities between well fluid, which is the mud filtrate and formation water in permeable beds, which is as a result of the different access charge carriers have in the well and formation fluids.

The main use of SP is to determine lithology, correlation, value of formation water resistivity.

For an SP to exist, the following requirement must be met:
1. A well or borehole fluid which must be conductive
2. A sandwich of a porous and permeable bed between low porosity and impermeable formations
3. A difference in the salinity between the well fluid and formation fluid. The direction of the SP curve deflection depends chiefly on the salinities of the formation water and mud filtrate. When $R!^w > R!^f$ the SP log will deflect to the left in the sand compared to the shale. And when $R!^w < R!^f$, the SP log will deflect to the right.

3. Gamma Ray
The gamma ray log is a continuous measurement that gives the value of the total gamma radiation that comes from a formation based on its radioactive isotope content and mineralogy.

The primary uses of gamma ray logs are for:
1. Evaluation of bed boundaries and correlation
2. Analysis of mineral deposits
3. Determination of the shale content of a formation

How the Gamma Ray log works
The gamma ray tool is a passive nuclear tool that uses a scintillation detector, which contains a crystal, usually sodium iodide. This scintillation detector serves as the gamma ray detector. When a gamma ray strikes the crystal, there is an immediate emission of a single photon of light. This flash of light hits the photocathode, and in the process, a number of electrons are released. These released electrons are in turn accelerated towards the next electrode to produce an even bigger number of electrons. The whole process is repeated multiple times till we get to the final electrode, where at that time the number of electrons released is quite large and will constitute an electric current, which after amplification can be measured by the tool. This electric current represents the number of gamma rate per unit of time and is recorded in American petroleum institute, API units which is 1/200th of the calibrated standard response. Clean formations such as sandstones and limestones because of their low level of radioactivity usually have very low GR log reading. On the other hand, shaly sands usually have a high GR log reading.

Input or Upload Example(s) of Assignment 5:

<table>
<thead>
<tr>
<th>Select Assignment 5 Type</th>
<th>Essay</th>
</tr>
</thead>
</table>

Essay evaluation criteria (max 10 points):
1) Content / Development;
2) Organization;
3) Research (Analysis);
4) Style;
5) Resources;
6) Timelines (total mark reducing for after deadline submission)
7) Plagiarism (total mark reducing for "copy"-"past"

10. Additional Notes