Identification	**Subject**	PETE 570 Numerical Reservoir Simulation – 8 ECTS
	Department	Petroleum and Natural Gas Engineering
	Program	Graduate
	Term	Fall 2025
	Instructor	Umid Shikhmammadov
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	Phone:	
	Classroom/hours	Saturdays
	Office hours	
Prerequisites	Reservoir Engineering, Calculus	
Language	English	
Compulsory/Elective	Compulsory	
Required textbooks and course materials	***Core textbooks:*** ***Basic Applied Reservoir Simulation,*** T. Ertekin, J.H.Abou-Kassem, G.R.King, 2001 ***Reservoir Simulation***, Heriot Watt manual, 2005 ***Supplementary material:*** Class Lecture Handouts and Additional Reading Materials	
Course outline	The course is designed for graduate students. Understanding of advanced reservoir engineering concept is strongly required along with mathematical concepts including solution of ordinary and partially differential equations (ODE and PDE). Some coding skills is expected from students for project implementation. **Project** is advised to be implemented using MATLAB but not limited to it (any other programming languages including C++, Java, Python, etc. are welcomed). Final exam is substituted with the project with the goal to build own reservoir simulator. Comparison to commercial simulators (eg. Eclipse 100) will be utilized for validation purposes. New technologies in various types of simulators will be examined and constructive summary provided. Homework assignments will be a building block for the project implementation. Fundamental concepts and their implementation using MATLAB will be tested. **Quizzes** are aimed to test students on particular topics. Group discussion among students and following presentation is demonstration phase of the project. The aim is to improve team work and presentation skills.	
Course objectives	The objectives are to improve analytical thinking and develop numerical computational skills regarding reservoir simulation and build own reservoir simulator. Implementation includes analysis of advanced reservoir engineering concepts, investigation of ODEs and PDEs used in reservoir simulation, linear algebra, numerical solution techniques. Although it is not a primary objective, use of commercial softwares is crucial. Case studies will be investigated.	
Learning outcomes	**By the end of the course the students should be able:** ▪ To apply reservoir engineering concepts for numerical simulation ▪ To manage input data ▪ To treat Parabolic and Hyperbolic equations ▪ To work with various types of discretization techniques in time and space	

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- To implement Cartesian grids construction
- To solve tridiagonal matrix equations
- To analyze Simultaneous and Implicit Pressure Explicit Saturation solution methods and their convergence properties
- To analyze Sequential Solution Method
- To solve pentadiagonal matrix equations including LU method
- To treat wells as source or sink terms
- To couple reservoir-wellbore hydraulics models
- To code own simulator
- To work with commercial software (eg. Eclipse)
- To link disciplines and data management used in reservoir simulation
- To analyze state-of-the-art advances of the current field
- To demonstrate ability for construction of other complicated models

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<tr><td rowspan="7">Teaching methods</td><td colspan="2">Lecture</td><td>X</td></tr>
<tr><td colspan="2">Group discussion</td><td>X</td></tr>
<tr><td colspan="2">Experiential exercise</td><td></td></tr>
<tr><td colspan="2">Simulation</td><td>X</td></tr>
<tr><td colspan="2">Case analysis</td><td>X</td></tr>
<tr><td colspan="2">Course papers</td><td>X</td></tr>
<tr><td colspan="2">Others</td><td></td></tr>
<tr><td rowspan="10">Evaluation</td><td>Methods</td><td>Date/deadlines</td><td>Percentage (%)</td></tr>
<tr><td>Midterm Exam</td><td></td><td>30</td></tr>
<tr><td>Case studies</td><td></td><td></td></tr>
<tr><td>Class Participation</td><td></td><td>5</td></tr>
<tr><td>Assignment and quizzes</td><td></td><td>20</td></tr>
<tr><td>Project</td><td></td><td>40</td></tr>
<tr><td>Presentation/Group Discussion</td><td></td><td>5</td></tr>
<tr><td>Final Exam</td><td></td><td>-</td></tr>
<tr><td>Others</td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td>100</td></tr>
<tr><td>Policy</td><td colspan="3">

- **Preparation for class**

  The structure of this course makes your individual study and preparation outside the class extremely important. The lecture material will focus on the major points introduced in the text. Reading the assigned chapters and having some familiarity with them before class will greatly assist your understanding of the lecture. After the lecture, you should study your notes and work relevant problems and cases from the end of the chapter and sample exam questions.

- **Withdrawal (pass/fail)**

  A student is normally expected to achieve a mark of at least 65 % to pass. In case of failure, he/she will be required to repeat the course the following term or year.

- **Cheating/plagiarism**

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	Cheating or other plagiarism during the Quizzes, Mid-term and Final Examinations will lead to paper cancellation. In this case, the student will automatically get zero (0), without any considerations. ▪ **Professional behavior guidelines** The students shall behave in the way to create favorable academic and professional environment during the class hours. Unauthorized discussions and unethical behavior are strictly prohibited.

Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook/Assignments
1	20.09.25	Introduction	Ch. 1, HW
2	27.09.25	Knowledge sharing of practical applications	Lecture Handouts
3	04.10.25	Basic Concepts in Reservoir Engineering Reservoir Simulation Model set-up	Ch. 2, HW Ch. 3, HW
4	11.10.25	Gridding in Reservoir Simulation	Ch. 4, HW
5	18.10.25	Wells in Reservoir Simulation	Ch. 4, HW
6	26.10.25	Single Phase Pressure equations	Ch. 5, HW
7	01.11.25	Single Phase Pressure equations	Ch. 5, HW
8		**Midterm Exam**	
9	15.11.25	Two Phase Flow equations	Ch. 5, HW
10	22.11.05	Two Phase Flow equations	Ch. 5, HW
11	29.11.25	Numerical Methods in Reservoir Simulation	Ch. 6, HW
12	06.12.25	Data Management	Lecture Handouts
13	13.12.25	Case Studies	Lecture Handouts
14	20.12.25	Compositional Simulators	Lecture Handouts
15	27.12.25	Thermal Simulators	Lecture Handouts
	TBA	**Project Submission**	

This syllabus is a guide for the course and any modifications to it will be announced in advance.