

Identification	Subject	PETE 509: Advanced Petroleum Reservoir Engineering- 8 ECTS credits	
	Department	Petroleum Engineering	
	Program	Graduate	
	Term	Spring,2018	
	Instructor	Tahir Mammadov	
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	Classroom/hours	11 Mehseti str. (Neftchilar campus), Room #xxxN, Monday	
	Office hours		
Prerequisites	Consent of instructor		
Language	English		
Compulsory/Elective	Required		
Required textbooks and course materials	<p><i>Core textbook:</i> Ahmed T. Reservoir Engineering Handbook, 2nd edition, 2001 L.P. Dake, Fundamentals of reservoir engineering, ELSEVIER, 2001 L.P. Dake, The practice of reservoir engineering, 1994 R. Cosse, Basics of reservoir engineering, 1993 and etc.</p>		
Course outline	<p>This course is prepared to gain high knowledge about Reservoir Engineering (RE) discipline. Reservoir analysis is the main concern of the course. The course combines theoretical foundations with practical applications. We will begin with a general overview in each topic and then go into more detail on several concepts. Finally, we will create ability to carry out engineering analysis and make optimization on Field Development Plans (FDP).</p>		
Course objectives	<p><i>Generic Objective of the Course:</i> This course explains the fundamentals of reservoir engineering and their practical application in conducting a comprehensive field study. 1st mid-term includes fundamentals of reservoir fluid behavior with an emphasis on the classification of reservoir and reservoir fluids. Here the fundamental mathematical expressions that are used to describe the reservoir fluid flow behavior in porous media. Principles of oil and gas well performances calculations are also discussed. Parallel you will be deeply familiar with water influx processes in reservoir. In the 2nd mid-term, it is introduced the basic principle of oil recovery mechanisms and presented by the generalized form of the material balance equation. Later, waterflooding and Enhanced Oil Recovery methods will be discussed. After gaining knowledge about Gas and fractured reservoirs, modern approach such as reservoir simulation will be discussed and illustrated at the end of the course.</p> <p>Projects will be dedicated to define reservoir type based on fluid composition and reservoir P, T, to design a spreadsheet that can input PVT data and calculate the following:</p> <ol style="list-style-type: none"> 1. Bubble point pressure 2. The formation volume factor at bubble point/dew point pressure 3. The oil/gas formation factor at any pressure in the reservoir 4. The gas oil /oil gas ratio at any pressure in the reservoir. <p>It will be started by the students, on week 14 to be completed independently within 2 weeks. Quizzes will be assigned each week.</p>		
Learning outcomes	<p>By the end of the course the students should be able:</p> <ul style="list-style-type: none"> ▪ Identify and articulate reservoirs by pressure-temperature diagrams ▪ Formulate and calculate different types of fluid flow in reservoir ▪ Classify numerical and analytical aquifers ▪ Understand recovery mechanisms by using Material Balance Equation ▪ Familiarize with Reservoir Simulation (Dynamic modeling) 		
Teaching methods	Lecture		X
	Group discussion		X
	Experiential exercise		X
	Simulation		X
	Case analysis		X
	Course paper		

	Others		
Evaluation	Methods	Date/deadlines	Percentage (%)
	Midterm Exam		30
	Case studies		
	Class Participation		5
	Assignment and quizzes		15
	Project		10
	Presentation/Group Discussion		
	Final Exam		40
	Others		
	Total		100

Policy	<ul style="list-style-type: none"> ▪ 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. ▪ Withdrawal (pass/fail) This course strictly follows grading policy of the School of Economics and Management. Thus, 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 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.
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Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook/Assignments
1	12.02.1	Introduction. Reservoir pressures and temperatures Classification of reservoirs and reservoir fluids <ul style="list-style-type: none"> • Abnormal pressures • Fluid pressures in hydrocarbon systems • Pressure gradients around water-oil contact • Techniques for pressure measurement • Reservoir temperature • Phase diagrams • Single-component system • Multi-component system • Oil reservoirs • Gas reservoirs • Ternary diagram • Properties of natural gases • Properties of crude oil systems 	
2	19.02.18	Fundamentals of reservoir fluid flow <ul style="list-style-type: none"> • Types of fluids: Incompressible, Slightly compressible and compressible 	

		<ul style="list-style-type: none"> Flow regimes: Steady-state, unsteady-state and pseudosteady-state Radial, linear and spherical and Hemispherical flows Flow equations, Darcy's Law Basic Transient Flow Equation 	
3	26.02.18	<p>Well performance</p> <ul style="list-style-type: none"> Well structure Skin factor Well stimulation : Acidizing & Hydraulic fracturing Oil well performance Vertical well performance Horizontal well performance <p>Gas well performance</p> <ul style="list-style-type: none"> Vertical gas well performance Horizontal gas well performance <p>Gas and water coning</p> <ul style="list-style-type: none"> Coning (stable and unstable) Critical production rate Breakthrough time 	
4	12.03.18	<p>Water influx</p> <ul style="list-style-type: none"> Classification of aquifers Recognition of natural water influx <p>Water influx models</p> <p>Oil recovery mechanisms and the Material Balance Equation</p> <ul style="list-style-type: none"> Primary recovery mechanisms: Rock and liquid expansion drive, depletion drive, gas cap drive, water drive, gravity drainage drive and combination drive Secondary recovery: Water and immiscible gas injections Tertiary recovery (EOR) <p>Material Balance Equation</p>	
5	19.03.18	<p>Principles of Waterflooding</p> <ul style="list-style-type: none"> Factors to consider in waterflooding: Reservoir geometry, fluid properties, reservoir depth, lithology and rock properties, fluid saturations Optimum time to waterflood Flood patterns <p>Displacement efficiency</p>	
6	26.03.18	Holiday	
7	09.04.18	<p>Enhanced oil recovery methods</p> <ul style="list-style-type: none"> Miscible methods (Natural and dynamic miscibilities; CO_2 injection) Chemical methods (Microemulsions, Polymers and Surfactants) <p>Thermal methods (Steam injection, In situ combustion and Reverse combustion)</p>	
8	16.04.18	Midterm Exam	
9	23.04.18	<p>Gas reservoirs</p> <ul style="list-style-type: none"> Natural gas Conventional gas reservoirs 	

		<p>Estimation initial gas in place: Volumetric method and Material balance approach</p> <ul style="list-style-type: none"> • Unconventional gas reservoir <p>Fractured reservoirs</p> <ul style="list-style-type: none"> • Naturally fractured reservoirs: fractured carbonates, fractured shales and fractured sandstones • Behavior of naturally fractured reservoirs <p>Hydraulically fractured wells</p>	
10	07.05.18	<p>Vapour liquid equilibria and PVT analyses</p> <ul style="list-style-type: none"> • Define equilibrium ratio • Derive equations for vapor-liquid equilibrium calculations for real systems and explain the application of the equations • Derive and explain the use of equations to determine the dew point pressure and bubble point pressure of a fluid mixture • Describe in general terms the impact of separator conditions on the gas-oil ratio and oil formation volume factor • Describe briefly the scope of PVT analysis • Describe the sampling options for oil systems • Describe the impact of well flow interruption on the sampling of 'wet' and gas-condensate systems • List the main items of equipment in PVT analysis • List and describe the five main PVT tests for oils systems and their application 	
11	14.05.18	<p>Immiscible displacement</p> <ul style="list-style-type: none"> • The reason for water injection • Basic water drive theory • Displacement theories • Two dimensional behavior-segregated Flow • Coping with heterogeneity • Application to field performance • Immiscible displacement in gas drive systems 	
12	21.05.18	<p>Reservoir modelling</p> <ul style="list-style-type: none"> • Geological modelling (static) • Software programs • Dynamic modelling (simulation) • Reservoir simulators • Simulation position in the field life • Methodology and advantages of reservoir simulation • "Black oil" and compositional models • Modules of typical reservoir simulators 	
13	29.05.18	Final Exam	
	TBA		

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

