Identification	**Subject**	PETE 538:Well Stimulation- 8 ECTS credits
	Department	Petroleum Engineering
	Program	Graduate
	Term	Fall 2017
	Instructor	Jabrayil Eyvazov
	E-mail:	jabrayil.eyvazov88@gmail.com
	Phone:	(+994 77) 531-12-31
	Classroom/hours	11 Mehseti str.(Neftchilar campus), Wednesday18:30-21:20
	Office hours	
Prerequisites	Consent of instructor	
Language	English	
Compulsory/Elective	Required	
Required textbooks and course materials	***Coretextbook:*** Reservoir Stimulation second edition – Michael J. Economides, Kenneth G. Nolte, 1989 Reservoir Stimulation third edition – Michael J. Economides, Kenneth G. Nolte, 2000 Reservoir Stimulation Ahmed S.Abou –Sayed, 2006	
Course outline	The main purpose of stimulation is to enhance the property value by the faster delivery of the petroleum fluid and/or to increase ultimate economic recovery. Matrix stimulation and hydraulic fracturing are intended to remedy, or even improve, the natural connection of the wellbore with the reservoir, which could delay the need for artificial lift. This chapter outlines stimulation techniques as tools to help manage and optimize reservoir development. Understanding stimulation requires understanding the fundamental issues of petroleum production and the position and applicability of the process.	
Course objectives	*Generic Objective of the Course:* **Stimulation** The need for well stimulation arises from either one of the following conditions: • Formation permeability is inadequate to allow the well to produce at rates high enough for the timely recovery of investment in drilling and completing the well. • The well has been completed in a formation having adequate permeability, but the formation near the wellbore has been damaged by the drilling or completion process. The first case, low formation permeability, requires a reservoir stimulation technique, which can be either hydraulic fracturing or acid fracturing. The second case, formation damage, requires a damage removal technique, which is usually matrix acidizing but may occasionally involve hydraulic fracturing. Solvent or surfactant treatments are sometimes used for damage removal. **Hydraulic Fracturing** The purpose of hydraulic fracturing is to change the flow pattern in the reservoir from one that converges radially on the well bore) with flow resistance concentrated near the wellbore, to one where flow in the reservoir is linear to a highly conductive fracture that conducts fluid to the wellbore with minimal flow resistance The success of this operation depends upon the conductivity of the hydraulic fracture and how successfully this conductivity can be retained following the treatment. These, in turn, depend largely upon the design and execution of the fracturing treatment. **Fracturing treatment**	

	A hydraulic fracture is created in a subsurface formation when a fluid is pumped into that formation at a rate faster than the formation can accept the fluid through its matrix permeability. It illustrates the pressure versus time behavior at the surface of a well that is being fractured. As fluid is pumped into the target formation at a rate sufficient to fracture the well, the pressure at the formation face builds up rapidly to the point that the formation fails and a fracture is developed. ***Acidizing*** Acidizing can be divided into three types of operations: • *Acid fracturing*, which involves injecting acid at rates above those that will be accepted by the matrix, fracturing the formation, and etching the face of the fracture to develop a permeable flow path • *Matrix acidizing*, which involves injecting acid at low rates to permit the uniform penetration of the formation without fracturing it • *Acid washing*, which involves using acid to dissolve scales and precipitates within the wellbore by moving acid across the encrusted surfaces. The acid used in acid washing seldom enters the formation and for that reason is not discussed further. ***Project objectives*** Well Stimulation Skin damage Major goal of matrix treatment Change in Damage Skin factor Applications for matrix treatment Matrix acidizing challenges ***Quizzes*** First quiz will be in 4th week and will be based on course materials which had been taught by between 1-3 weeks. Second quiz will be in 7th week and will be based on course materials which had been taught by between 5-7 weeks.	
Learning outcomes	**By the end of the course the students should be able to learn :** ▪ Reservoir Stimulation in Petroleum Production ▪ Inflow performance ▪ Tubing performance and Nodal analysis ▪ Well and reservoir testing ▪ Rock mechanics ▪ Rock and fluid mechanics ▪ Hydraulic fracturing ▪ Mechanics of hydraulic fracturing ▪ Fracturing Fluid Chemistry and Proppants ▪ Fracture Treatment Design ▪ Sandstone and carbonate acidizing design	
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 two quizzes		15
	Project		10
	Presentation/Group Discussion		
	Final Exam		40
	Others		
	Total		100

Policy

- **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.
  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	20.09.17	Reservoir Stimulation in Petroleum Production • Introduction • Inflow Performance • Alterations in the near wellbore zone • Tubing performance and Nodal Analysis • Decision process for well stimulation • Reservoir engineering considerations for optimal production enhancement strategies	
2	27.09.17	Formation Characterization : Well and Reservoir Testing • Evolution of a technology • Pressure derivative in well test diagnosis	

		• Parameter estimation from pressure transient data • Test interpretation methodology • Analysis with measurement of layer rate • Layered reservoir testing • Testing multilateral and multi-branch wells • Permeability determination from a fracture injection test	
3	04.10.17	Formation Characterization : Rock Mechanics • Introduction • Basic concepts • Rock behavior • Rock mechanical property measurement • State of stress in the earth • In-situ stress measurement	
4	11.10.17	Formation Characterization: Well Logs • Introduction • Depth • Temperature • Properties related to the diffusion of fluids • Properties related to the deformation and fracturing of rock	
5	18.10.17	Basics of Hydraulic Fracturing • Introduction • In-situ stress • Reservoir engineering • Rock and fluid mechanics • Treatment pump scheduling • Economics and operational considerations	
6	25.10.17	Mechanics of Hydraulic Fracturing • Introduction • Leakoff • Proppant placement • Heat transfer models • Fracture tip effects • Acid fracturing • Multilayer fracturing	
7	01.11.17	Fracturing Fluid Chemistry and Proppants • Introduction • Water-base fluids • Oil-base fluids • Acid-Based fluids • Multiphase fluids • Additives • Proppants	
8	08.11.17	Performance of Fracturing Materials • Introduction • Fracturing fluid characterization • Characterization basics • Rheology • Proppant effects • Fluid loss	

9	15.11.17	**Midterm Exam**	
10	22.11.17	Introduction to Matrix Treatments • Introduction • Candidate Selection • Formation damage characterization • Stimulation technique • Treatment design • Treatment evaluation	
11	29.11.17	Formation Damage : Origin , Diagnosis and Treatment Strategy • Introduction • Damage characterization • Formation damage descriptions • Origins of formation damage • Treatment strategies and concerns	
12	06.12.17	Additives in Acidizing Fluids • Introduction • Corrosion inhibitors • Surfactants • Iron control additives • Alcohols • Acetic acid • Organic dispersants • Organic solvents • Additive compatibility	
13	13.12.17	Presentation(Project)	
14	20.12.17	Fundamentals of Acid Stimulation • Acid mineral interactions • Sandstone acidizing • Carbonate acidizing	
15	27.12.17	Carbonate and Sandstone Acidizing • Rock and damage characteristics in carbonate formations • Carbonate acidizing with hydrochloric acid • Carbonate acidizing treatment design • Sandstone acidizing treating fluids • Damage removal mechanisms • Acid treatment design considerations • Matrix acidizing design guidelines • Acid treatment evaluation	
	TBA	**Final Exam**	

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