|  |  |  |
| --- | --- | --- |
| **Identification** | **Subject**  | PETE 551:Enhanced Oil Recovery- 4 credits |
| **Department** | Petroleum Engineering |
| **Program** | Graduate |
| **Term** | Fall, 2016 |
| **Instructor** | Jabrayil Eyvazov |
| **E-mail:** | jabrayil.eyvazov88@gmail.com  |
| **Phone:** | (+994 77) 531-12-31 |
| **Classroom/hours** | 11 Mehseti str.(Neftchilar campus), Thursday18:30-21:20 |
|  | **Office hours** |  |
| **Prerequisites** | Consent of instructor |
| **Language**  | English |
| **Compulsory/Elective** | Required |
| **Required textbooks and course materials** | ***Coretextbook:***Aurel Carcoana, Applied Enhanced Oil Recovery, 1992Erle C. Donaldson- Enhanced Oil Recovery, I Fundamentals and AnalysesErle C. Donaldson- Enhanced Oil Recovery, II Processes and OperationsMarcel Latil- Enhanced Oil Recovery |
| **Course outline** | Enhanced oil recovery (EOR) is oil recovery by the injection of materials notnormally present in the reservoir. This definition covers all modes of oil recoveryprocesses (drive, push-pull, and well treatments) and most oil recovery agents.Enhanced oil recovery technologies are also being used for in-situ extraction oforganic pollutants from permeable media. In these applications, the extraction isreferred to as cleanup or remediation, and the hydrocarbon as product. ***Project:*** Primary Recovery –How pressure originated from various forces in during Primary Recovery processSecondary Recovery –The purpose of a secondary recovery techniqueWater injectionGas injectionWhen to start EOR?Tertiary Oil Recovery Methods***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.  |
| **Course objectives**  | *Generic Objective of the Course:***Hydrocarbon Recovery**Hydrocarbon recovery occurs through two main processes: primary recovery and supplementary recovery. Primary recovery refers to the volume of hydrocarbon, produced by the natural energy prevailing in the reservoir and/or artificial lift through a single wellbore; while supplementary or secondary hydrocarbon recovery refers to the volume of hydrocarbon produced as a result of the addition of energy into the reservoir, such as fluid injection, to complement or increase the original energy within the reservoir.**Primary oil recovery mechanisms**The natural driving mechanisms of primary recovery are outlined as follows.* Rock and liquid expansion drive
* Depletion drive
* Gas cap drive
* Water drive
* Gravity drainage drive
* Combination drive

**Supplementary or secondary hydrocarbon recovery**Secondary hydrocarbon (oil and/or gas) involves the introduction of artificial energy into the reservoir via one wellbore and production of oil and/or gas from another wellbore. Usually secondary recovery include the immiscible processes of water flooding and gas injection or gas-water combination floods, known as water alternating gas injection (WAG), where slugs of water and gas are injected sequentially. Simultaneous injection of water and gas (SWAG) is also practiced, however the most common fluid injected is water because of its availability, low cost, and high specific gravity which facilitates injection.**Enhanced Oil Recovery** Tertiary or enhanced recovery refers to processes in the porous medium that recover oil not produced by the conventional primary and secondary production methods. By EOR is meant to improve the sweep efficiency in the reservoir by use of injectants that can reduce the remaining oil saturation below the level achieved by conventional injection methods. Included in remaining oil defined here are both the oil trapped in the flooded areas by capillary forces (residual oil), and the oil in areas not flooded by the injected fluid (bypassed oil). |
| **Learning outcomes** | **By the end of the course the students should be able to learn :*** Primary Recovery
* Secondary Recovery
* Water Injection
* Gas Injection
* Limitations and disadvantages of Primary and Secondary Recovery Processes
* Tertiary or Enhanced Oil Recovery Methods
* Chemical Processes
* Miscible displacement methods
* Thermal Processes
 |
| **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 | 15.09.16 | Geological Factors in Enhanced Oil Recovery * Reservoir heterogeneities
* Examples of geological factors in enhanced recovery projects
* Natural fractures
 |  |
| 2 | 22.09.16 | Determination of Residual Oil Saturation based on Geophysical Well logging techniques* Determination of residual saturation
* Well-log-derived oil saturation determination in open hole
* Residual oil saturation determination in cased wellbore
 |  |
| 3 | 29.09.16 |  Gas Injection * Predictive techniques
* Reservoir performance
* Gas Injection
* Gas Injection in carbonate reservoirs
* Inert Gas Injection
* Candidates for gas injection
 |  |
| 4 | 06.10.16 | Miscible Flooding * Sweep efficiency
* High-pressure gas injection
* Enriched –gas drive
* Liquid petroleum gas slug drive
* Predictive techniques
* Field applications
 |  |
| 5 | 13.10.16 | Carbon Dioxide Flooding* Process description
* Field projects
* Carbon dioxide sources
* Problem areas
* Designing o CO2 flood
* Guidelines for selection of miscible CO2 projects
* Immiscible CO2 flooding
 |  |
| 6 | 20.10.16 | Polymer Flooding * Polymer products and theory of use
* Planning polymer flood projects
 |  |
| 7 | 27.10.16 | Polyacrylamides* Polyacrylamide chemistry
* Application of Polyacrylamide in enhanced oil recovery
* Factors affecting flow in porous media
* Field considerations
* Site factors
* Field operation
 |  |
| 8 | 03.11.16 | Alkaline Flooding* Types of caustic used
* Entrapment of residual oil
* Displacement mechanisms in alkaline flooding
* Crude oil properties
* Alkali consumption
* pH of injected caustic
* Effect of sodium ions and sodium chloride
* Reservoir selection
 |  |
| 9 | 10.11.16 | **Midterm Exam** |  |
| 10 | 17.11.16 | Use of Surfactants in oil recovery* Classification of EOR surfactants
* Mechanism of oil displacement by surfactant flooding
* Factors influencing oil recovery
* Surfactant-gas flooding for oil recovery
* Mechanism of surfactant loss in porous media
* Present status of the use of surfactants in oil recovery
 |  |
| 11 | 24.11.16 | Steam flooding for Enhanced Oil Recovery* Screening criteria for steam flood prospects
* Reservoir rock and fluid properties
* Heat losses and formation heating
* Oil recovery calculations
* An overview of stemaflood modeling
* Parametric studies in steamflooding
* Economies of the steamflooding process
 |  |
| 12 | 01.12.16 | Operational aspects of steam injection processes* Water treatment for steam generation
* Steam generators
* Determination of steam quality
* Production facilities
 |  |
| 13 | 08.12.16 | Presentation(Project) |  |
| 14 | 15.12.16 | In-situ combustion technology* Reservoir characteristics
* Ignition
* Ignition methods
* Process of in-situ combustion
* Use of in-situ combustion
 |  |
| 15 | 22.12.16 | Microbial enhanced oil recovery* Laboratory experiments show the potential of microbial enhancement of oil recovery
* Field applications of microbial enhancement of oil recovery
* Microbial interactions with produced oil
* Potential of microbial enhancement of oil recovery
 |  |
|  |  | **Final Exam** |  |
|  | TBA |  |  |

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