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| **Identification** | **Subject**  | PETE 565- Fluid Flow in Porous Media – 4 credits  |
| **Department** | Petroleum Engineering |
| **Program** | Graduate |
| **Term** | Fall, 2015 |
| **Instructor** | PhD. Abbas Khaksar Manshad  |
| **E-mail:** | khaksar@put.ac.ir |
| **Phone:** | (+994 55) 671-25-34 and (+98 919) 395-18-99 |
| **Classroom/hours** | 11 Mehseti str. (Neftchilar campus), Wednesday 18:00-22:00Friday 18:00-20:00 |
|  | **Office hours** | Wednesday 14:00-18:00Friday 14:00-18:00 or by appointment |
| **Prerequisites** | Consent of instructor |
| **Language**  | English |
| **Compulsory/Elective** | Required |
| **Required textbooks and course materials** | ***Core textbook:**** ***Multiphase Flow in Porous Media*** *by Charles M. Marle*
* ***Flow of Fluids through Porous Materials*** *by Royal Collins*
* ***Porous Media: Fluid Transport and Pore Structure*** *by F. A. L. Dullien*

***Supplementary:**** ***Fluid Flow in Porous Media*** *by Zoltán E. Heinemann*
* ***Advanced Reservoir Engineering*** *by Tarek Ahmed*
* ***Flow and Transport in Fractured Porous Media*** *by P. Dietrich*
* ***Flow and Transport in Porous Media and Fractured Rock*** *by M. Sahimi*
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| **Course website** |  |
| **Course outline** | This course is designed for the master students. Course addresses Dimensionless Numbers, Governing Equations of fluid flow in HC reservoirs (Porous Media), Microscopic Origin of Petro physical Properties, Pore Scale Network Modeling (Relative Permeability and Capillary Pressure Modeling), Interfacial Tension and Capillarity - Interfacial Tension - Capillary Pressure - Residual Saturations - Wettability- , Multiphase Flow in Porous Media - Relative Permeability , Multiphase Displacement - Immiscible Displacement - Equations of Motion – Buckley - Leverett Theory One-Dimensional Flow - Derivation of Relative Permeability from Displacements - Gravity Segregation , Displacement in a tilted layer: Effect of Gravity, Displacement in a Heterogeneous Medium: Effects of Capillarity and Imbibition - Effect of Heterogeneity on Saturation Distribution Control by Capillary, Miscible Fluid Displacement, Instability Phenomena. |
| **Course objectives**  | *Generic Objective of the Course:** To develop an understanding of the basic physical characteristics of porous media and the fluids contained therein,

*Specific Objectives of the Course:** To understand and appreciate the mechanisms that drive fluid flow in porous media and,
* To apply this knowledge to some of the more complex problems of fluid flow through porous media.
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| **Learning outcomes** | By the end of the course the students should be able to learn:* Understanding and modeling of multiphase flow in geological formation.
* We will pay particular attention to the following two models:

1) incompressible two-phase immiscible flow and 2) Compositional miscible multiphase flow. * We will be formulated and discussed in details for the pressure equation and the saturation equation (for immiscible flow) or the species transport equation (for compositional flow).
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| **Teaching methods** | **Lecture**  | x |
| **Group discussion** | x |
| **Experiential exercise** | x |
| **Simulation** | x |
| **Case analysis** | x |
| **Course paper** | x |
| **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** | * **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.Throughout the semester we will also have an assignment. * **Withdrawal (pass/fail)**

This course strictly follows grading policy of the School of Engineering and Applied Science. Thus, a student is normally expected to achieve a mark of at least 60% 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 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 | 30.09.151.10.152.10.15 | Dimensionless Numbers |  |
| 2 | 30.09.151.10.152.10.15 | Governing Equations of fluid flow in HC reservoirs (Porous Media) |  |
| 3 | 14.10.1515.10.1516.10.15 | Microscopic Origin of Petro physical Properties |  |
| 4 | 14.10.1515.10.1516.10.15 | Microscopic Origin of Petro physical Properties |  |
| 5 | 28.10.1529.10.1530.10.15 | Pore Scale Network Modeling (Relative Permeability and Capillary Pressure Modeling) |  |
| 6 | 28.10.1529.10.1530.10.15 | Interfacial Tension and Capillarity - Interfacial Tension - Capillary Pressure - Residual Saturations - Wettability |  |
| 7 | 12.11.1513.11.1514.11.15 | Multiphase Flow in Porous Media - Relative Permeability |  |
| 8 | 12.11.1513.11.1514.11.15 | **Mid-term Exam** |  |
| 9 | 26.11.1527.11.1528.11.15 | Multiphase Displacement - Immiscible Displacement - Equations of Motion - Buckley-Leverett Theory One-Dimensional Flow |  |
| 10 | 26.11.1527.11.1528.11.15 | Derivation of Relative Permeability from Displacements - Gravity Segregation |  |
| 11 | 10.12.1511.12.1512.12.15 | Displacement in a tilted layer: Effect of Gravity |  |
| 12 | 10.12.1511.12.1512.12.15 | Displacement in a Heterogeneous Medium: Effects of Capillarity and Imbibition - Effect of Heterogeneity on Saturation Distribution Control by Capillary |  |
| 13 | 24.12.1525.12.1526.12.15 | Miscible Fluid Displacement |  |
| 14 | 24.12.1525.12.1526.12.15 | Instability Phenomena |  |
|  | TBA | **Final Exam** |  |

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