جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Modeling Naturally Fractured Reservoirs - ERPE 351

Division	Physical Science and Engineering Division
Course Number	ERPE 351
Course Title	Modeling Naturally Fractured Reservoirs
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Hussein Ali Hoteit	HUSSEIN.HOTEIT@KAUST.EDU.SA	+966128084897	3221, 5, Al-Kindi (bldg. 5)	Email for appointment

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	Modeling naturally fractured reservoirs (NFR) is regaining interest in the industry and academia thanks to the revolution in unconventional hydrocarbon and EOR in carbonate fractured reservoirs. This course provides an overview of naturally fractured reservoirs (NFR) and focuses on traditional and advanced methods to model NFR. The course includes: 1) Introduction on NFR: definitions, importance, detection methods, characterization; 2) Single porosity model: multiphase flow, matrix-fracture interaction (diffusion, imbibition, infiltration), gridding, limitations; 3) dual porosity/dual-permeability models: derivations, shape factor, transfer functions, limitations; 4) Discrete fractured models; 2D/3D gridding simplifications; 5)Advanced methods; Finite Element (FE), Control-Volume FE, Mixed FE; 6) DFN upscaling: static/dynamic upscaling, single-phase/multi-phase upscaling.
Course Description from Program Guide	Overview of naturally fractured reservoirs (NFR) and modeling methods. (1) Introduction to NFR: definitions, importance, detection methods, characterization. (2) Single porosity model: multiphase flow, matrix- fracture interaction (diffusion, imbibition, infiltration), gridding, limitations. (3) Dual porosity/dual permeability models: derivations, shape factor, transfer functions and limitations. (4) Discrete fractured models; 2D/3D gridding simplifications. (5) Advanced methods; Finite Element FE, Control-Volume FE, Mixed FE. (6) DFN upscaling: static/dynamic upscaling, single-phase/multi-phase upscaling. (7) Class project. Course programming assignments will require MATLAB, Fortran or C/C++.
Goals and Objectives	After completing this course, students will be able to : - understand the significance of NFR and the complexity in their modeling - know about different secondary and tertiary recovery schemes in conventional and unconventional NFR - know about key multiphase flow mechanisms in NFR such as capillarity, gravity, wettability and diffusion - know about the traditional single-porosity and dual-porosity/dual-permeability methods in modeling NFR, their strength and limitations - get familiarized with the state-of-the-art in discrete fractured reservoir modeling using finite-element based methods - get familiarized with reservoir simulation development
Required Knowledge	Students are expected to have at least basic familiarity with: Multi-phase flow in porous media, and programming in Matlab

Reference Texts	- Course material - P. Dietrich et al., Flow and Transport in Fractured Porous Media, Springer, 2005 - Y. Wu, Multiphase Fluid Flow in Porous and Fractured Reservoirs, Elsevier 2016 - T. Ertekin, J. Abou-Kassem and G. King; Basic Applied Reservoir Simulation, SPE 2001.
Method of evaluation	**35.00**% - Midterm exam **20.00**% - Homework /Assignments **35.00**% - Course Project(s) **10.00**% - Active participation
Nature of the assignments	- Model coding in Matab or Python - Written assignments - Paper presentation - Group project with a presentation
Course Policies	For absense and late assignements, discusss with instructor beforehand
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/26/2019	Introduction to Reservoir Engineernig and to the course content
1	Thu 08/29/2019	Importance of NFR, fracture types, NFR classification, fracture detection methods
2	Mon 09/02/2019	Characterization workflow: data acquisition, analysis, stochastic,upscaling
2	Thu 09/05/2019	Characterization workflow: data acquisition, analysis, stochastic,upscaling
3	Mon 09/09/2019	Flow mechanisms in NFR(wettability, capillarity, gravity, diffusion, viscous forces)
3	Thu 09/12/2019	Flow mechanisms in NFR(wettability, capillarity, gravity, diffusion, viscous forces)
4	Mon 09/16/2019	Modeling methods: single porosity model
4	Thu 09/19/2019	Modeling methods: single porosity model
5	Mon 09/23/2019	Saudi National Day
5	Thu 09/26/2019	Dual porosity/dual permeability models
6	Mon 09/30/2019	Dual porosity/dual permeability models
6	Thu 10/03/2019	Discrete fractured network (DFN) modeling : finite element based methods, 2D gridding
7	Mon 10/07/2019	Discrete fractured network (DFN) modeling : finite element based methods, 2D gridding
7	Thu 10/10/2019	DFN modeling: FD based methods
8	Mon 10/14/2019	DFN modeling: FD based methods
8	Thu 10/17/2019	DFN modeling : finite-volume based methods
9	Mon 10/21/2019	Reservoir simulation training (DFN/Dual porosity)
9	Thu 10/24/2019	Reservoir simulation training (DFN/Dual porosity)
10	Mon 10/28/2019	Mid-semester break
10	Thu 10/31/2019	Mid-semester break
11	Mon 11/04/2019	Midterm Exam
11	Thu 11/07/2019	Finite-Element (FE) based methods
12	Mon 11/11/2019	Mixed FE based methods
12	Thu 11/14/2019	Final project description
13	Mon 11/18/2019	Molecular diffusion in fractured media
13	Thu 11/21/2019	Co-current/counter-current flow in fractured media
14	Mon 11/25/2019	Capillarity effect (water-wet vs. oil-wet vs. mixed-wet)
14	Thu 11/28/2019	Static-based upscaling
15	Mon 12/02/2019	Single-phase upscaling
15	Thu 12/05/2019	Two-phase upscaling
16	Mon 12/09/2019	Exams

Note

The instructor reserves the right to make changes to this syllabus as necessary.