UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCES AND ENGINEERING

RESERVOIR SIMULATION

MSc in Petroleum Engineering **MFKOT710012**

COURSE DESCRIPTION

FACULTY OF EARTH AND
ENVIRONMENTAL SCIENCES AND ENGINEERING
MINING AND ENERGY INSTITUTE

2026. Fall Term

Course Data Sheet

Course Title: Reservoir Simulation **Instructor:** Dr. Zoltán TURZÓ associate professor	**Code:** MFKOT710012 **Responsible department/institute:** DPE/IPNG (OMTSZ/BEI) **Course Element: Compulsory**
Position in curriculum* **(which semester)**: 1 (3)	**Pre-requisites (if any):**
No. of contact hours per week (lecture + seminar): 0+4	**Type of Assessment (examination / practical mark / other):** practical mark
Credits: 5	**Course:** full time

Course Description:

Reservoir simulation overview. Main Features of ECLIPSE Black Oil Simulator (E100)
PETREL RE as a postprocessor
RUNSPEC section
GRID section
PROPS section
REGIONS section
SOLUTION section
Aquifer modeling facilities
SUMMARY section
SCHEDULE section
History matching
Predictive Simulations
PETREL RE as pre-processor
Case studies

Competencies to evolve:

Knows the economic processes related to the hydrocarbon industry.

Knows the properties of the fluids found in petroleum, natural gas and geothermal reservoirs, as well as the storage rocks; characteristics of flow in such reservoirs.

Knows the production mechanisms of underground reservoirs and the primary or enhanced extraction mechanisms that ensure optimal production.

Knows the basics of numerical simulation of underground storages.

Knows the methods and tools of computerized design and analysis in the hydrocarbon industry.

Ability:

Able to interpret the economic processes related to the hydrocarbon industry and to give adequate answers to them.

Capable of predicting the behavior of fluids in petroleum, natural gas, and geothermal reservoirs, the properties of reservoir rocks, and the characteristics of flow in such reservoirs.

Able to recognize the production mechanisms of underground reservoirs and select the primary or enhanced extraction mechanisms that provide optimal production.

Capable of numerical simulation of underground storages.

Able to select equipment for field and transmission line transport and supervise the operation of the equipment and manage the participating groups.

Capable of hydrocarbon industrial computer design and analysis.

Attitude:

Autonomy and responsibility:

Able to independently manage hydrocarbon industrial complex planning works and perform project management tasks, or participate in them.

Capable of independently choosing the appropriate mechanisms for the production of underground reservoirs; to implement the most favorable "reservoir management".

Able to autonomously plan the use of energy carriers produced from renewable natural resources and residual materials in the energy supply system, and manage the operation of the established system.

Takes responsibility for his/her professional decisions and the work processes carried out by him/her or under his/her control.

Assessment and grading:	Grading scale:	
Students will be assessed with using the following elements.	% value	Grade
Attendance: 5 %	90 -100%	5 (excellent)

Midterm exam	40 %	80 – 89%	4 (good)
Final exam	55 %	70 - 79%	3 (satisfactory)
Total	100%	60 - 69%	2 (pass)
		0 - 59%	1 (failed)

Compulsory or recommended literature resources:

- Fanci: Principles of Applied Reservoir Simulation, Gulf Publishing Co. 2001, ISBN 0-88415-372-X
- Ertekin – AbouKassem - King: Basic Applied Reservoir Simulation, SPE Textbook Series, 2001, ISBN 1-55563-089-8
- T. Ahmed: Advanced Reservoir Engineering, Gulf Publishing Co. 2005, ISBN-13: 978-0-7506-7733-2
- A. Satter: Integrated Petroleum Reservoir management: A Team Approach. Pennwell Books, 1994, ISBN 0-87814-408-0
- A. Satter: Computer Assisted Reservoir Management Pennwell Books, **ISBN:** 978-0-87814-777-9

Course Schedule for 2026/27 school year, fall term

Date	Topic
2026.09.09	Reservoir simulation overview. Main Features of ECLIPSE Black Oil Simulator (E100)
2026.09.16	PETREL RE as a postprocessor
2026.09.30	RUNSPEC section; GRID section
2026.10.07	PROPS section
2026.10.14	REGIONS section
2026.11.04	SOLUTION section Aquifer modeling facilities;
2026.11.11	SUMMARY section;
2026.11.18	SCHEDULE section
2026.11.25	History matching; Predictive Simulations
2026.12.02	PETREL RE as a pre-processor
2026.12.09	Test writing

Test example

CLOSED BOOK

Name of Student: «Name»

Field DUDUJKA is at its primary recovery stage. The start of the simulation is 1st of January 2015.

The geological information indicates that the reservoir according to similar rock properties can be divided into 2 regions by a vertical X-Z layer and in each region 10 layers is sufficient to capture the reservoir heterogeneities in Z(k) direction. Assign different FIP number for the two regions!

Based on the amount of data available and the computer resources, it has been decided to run the simulation using a 3D model.

The dimensions of the reservoir:

Extent in X (i) direction, [m]: «Res_length_X»

Extent in Y (j) direction, [m]: «Res_Length_Y»

Height of reservoir Z(k), [m]: «Res_Height»

For horizontal grid block dimensions (X and Y) use 100 m!

The boundary the forementioned two regions of the reservoir is parallel with the X (j) side of the reservoir.

The pozition of the boundary in Y direction is, [m]: «reg_y_location»

The permeability and porosity data of Region I is in the following table for each layer:

Region I.		
Layer	Kx, Ky, mD	Poro
1	231	0.17
2	244	0.17
3	29	0.06
4	250	0.17
5	257	0.17
6	191	0.17
7	333	0.19
8	334	0.19
9	287	0.18
10	262	0.18
The Kz/Kx ratio is 0.1		

For Region II of the reservoir Kx and Ky values are 90% of Region I layers values! The Kz/Kx ratio is 0.13!

Seismic data indicates that there is an aquifer attached to the field, probably from the southern direction (max j side). Use an analytical aquifer (Fetkovich) to model the aquifer volume.). Aquifer is estimated to contain approximately 10 MMstb of water and could supply the reservoir at a rate of 5 bbl/day/psi.

There are five producers wells. Producers that are close to the aquifer can be converted to injectors later, and you can drill as many as two infill wells at a later date.

The reservoir oil is initially under-saturated, but with production, the reservoir pressure has dropped below the bubble point pressure. The fluid properties are believed to be constant throughout the reservoir.

At surface conditions, the oil density is 667.26 kg/m^3, the density of the water is: 1000.03 kg/m^3 and the gas density is: 1.55 kg/m^3.

From PVT analysis, properties have been obtained for the oil and gas. The data is presented in the following tables:

Oil PVT Data			
Saturated Data			
Pressure	**GOR**	**FVF**	**Viscosity**
(bara)	**(Sm^3/Sm^3)**	**(m^3/Sm^3)**	**(cp)**
17.2	24.4	1.274	0.107
34.5	65.5	1.459	0.094
39.3	77.1	1.510	0.091
40.5	80.0	1.523	0.090
41.8	83.0	1.536	0.089
44.2	89.0	1.562	0.088
53.9	114.4	1.674	0.083
73.3	173.2	1.934	0.073

Undersaturated Data (GOR=173.2 Sm^3/Sm^3)			
Pressure (bara)	FVF (m^3/Sm^3)	Viscosity (cp)	Comments
73.3	1.934	0.073	Saturation Pressure
103.4	1.871	0.081	
123.0	1.838	0.085	
137.9	1.816	0.089	
172.4	1.773	0.097	
209.4	1.735	0.105	
234.5	1.714	0.111	

Gas PVT Data

Pressure (bara)	FVF (m^3/Sm^3)	Viscosity (cp)
17.2	12.651	0.012
34.5	6.076	0.013
39.3	5.662	0.013
40.5	5.558	0.013
41.8	5.455	0.013
44.2	5.248	0.013
53.9	4.420	0.013
73.3	3.413	0.014
103.4	2.037	0.016
123.0	1.494	0.018
137.9	1.326	0.019
172.4	1.073	0.023
209.4	0.916	0.026
234.5	0.845	0.029

The initial solution gas-oil ratio of the reservoir oil is 173.2 Sm^3/Sm^3, so the corresponding table can represent a constant composition expansion of that oil above the bubble point.
The water formation volume factor B_w is 1.013 m^3/Sm^3 at 215 bar with constant water viscosity μ_w 0.4 cP and compressibility 3.97E-5 1/bar.
From special core analysis, two-phase relative permeability and capillary pressure curves have been obtained:

Oil - Water Saturation Table Data				
Water Sat.	Oil Sat.	Water Rel. Perm	Oil Rel. Perm	Oil-Wat. Cap. Pres.
0.2	0.8	0	0.9	3.45
0.22	0.78	0	0.8032	3.1
0.3	0.7	0.0005	0.487	1.72
0.4	0.6	0.0092	0.2206	0.86
0.5	0.5	0.0453	0.0776	0.43
0.6	0.4	0.1537	0.0136	0.17
0.7	0.3	0.387	0.0007	0.09
0.73	0.27	0.4803	0	0.08
0.8	0.2	0.8	0	0.06
1	0	1	0	0

Gas - Oil Saturation Table Data				
Gas Sat.	Oil Sat.	Gas Rel. Perm	Oil Rel. Perm	Oil-Gas Cap. Pres.
0	0.8	0	0.9	0
0.062	0.738	0	0.5251	0
0.0952	0.7048	0.0001	0.3752	0
0.1429	0.6571	0.0004	0.2134	0
0.1905	0.6095	0.0017	0.1061	0
0.2381	0.5619	0.006	0.0421	0
0.2857	0.5143	0.0127	0.0107	0
0.3333	0.4667	0.0352	0.0012	0
0.37	0.43	0.0606	0	0
0.8	0	0.9	0	0

The rock compressibility is 4.06E-5 1/bar at 400 bara.

From the results of wells drilled throughout the reservoir, the OWC has been determined as 2500 m, which is coincident with the free water level. From well logs, the pressure is 209.36 bara at a depth of 2133.6 m. No GOC is thought to exist in the reservoir. Fetkovich aquifer model should be used. Place its datum depth at the OWC and ensure that it is in initial equilibrium with the reservoir.

Total compressibility is near 1.45E-4 1/bar.

For the initialization of the simulation use center block equilibration!

There are already 5 vertical wells drilled. All wells have an internal diameter of 0.19 m and a skin factor of 7.5.

Data of wells:

Well Name	Group	Well Head		Perforation	
		I	J	K1	K2
PROD1	OP	13	8	1	10
PROD2	OP	7	12	1	8
PROD3	OP	16	10	2	8
PROD4	OP	3	3	2	5
PROD5	OP	12	7	1	10

Create the DATA deck (*.DATA) file for the simulation!

Use:

METRIC units,

unified input and output,

block centered grid

Request output of : the grid geometry file (*.EGRID),

the static reservoir properties file (*.INIT),

the X direction transmissibility into the PRINT file (*.PRT),

initial restart file at time zero,

fluid-in-place report for the field and the regions.