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PRESIDENCY UNIVERSITY, BENGALURU
SCHOOL OF ENGINEERING

Max Marks: 80

Max Time: 120 Mins

Weightage: 40 %

ENDTERM FINAL EXAMINATION

I Semester AY 2017-18 Course: **PET 209 RESERVOIR ENGINEERING -I** 18 DECEM 2017

Instructions:

- i. Write legibly
- ii. Scientific and non-programmable calculators are permitted

Part A

[5 Q x 10 M= 50 Marks]

1. Illustrate conventional and enhanced oil recovery mechanisms with a flow chart
2. i. For selection of waterflooding pattern what factors must be considered [3M]
ii. Draw any of the 7 Regular water flooding patterns used in the industry with notations [7M]
3. Write a brief notes on following
i. Coning and specific problems of water and gas conning [3M]
ii. Aquifers and Reservoir-aquifer systems classification on the basis of flow geometry [2M]
iii. Three types of production decline curves and their cumulative production rate equation [5M]
4. After producing 360 MMscf of gas from a volumetric gas reservoir, the pressure has declined from 3200 psi to 3000 psi, given: $B_{gi} = 0.005278 \text{ ft}^3/\text{scf}$, $B_g = 0.005390 \text{ ft}^3/\text{scf}$
i. Calculate the gas initially in place.
ii. Recalculate the gas initially in place assuming that the pressure measurements were incorrect and the true average pressure is 2900 psi. The gas formation volume factor at this pressure is 0.00558 ft^3/scf .
5. A vertical well is drilled in an oil reservoir overlaid by a gas cap. The related well and reservoir data are given below:
Horizontal and vertical permeability, i.e., $k_h, k_v = 110 \text{ md}$
Oil relative permeability, $k_{ro} = 0.85$
Oil density, $\rho_o = 47.5 \text{ lb/ft}^3$
Gas density, $\rho_g = 5.1 \text{ lb/ft}^3$

Oil viscosity, $\mu_o = 0.73$ cp

Oil formation volume factor, $B_o = 1.1$ bbl/STB

Oil column thickness, $h = 40$ ft

Perforated interval, $h_p = 15$ ft

Depth from GOC to top of perforations, $D_t = 25$ ft

Wellbore radius, $r_w = 0.25$ ft

Drainage radius, $r_e = 660$ ft

i. Using the Meyer and Garder relationships, calculate the critical oil flow rate.

ii. For above data assuming that the oil zone is underlaid by bottom water. The water density is given as 63.76 lb/ft³. The well completion interval is 15 feet as measured from the top of the formation (no gas cap) to the bottom of the perforations.

Part B

[1 Q x 30 M= 30 Marks]

6. i. Write the general material balance equation, modified material balance equation by introducing total formation volume factor (B_t), where $B_t = B_o + (R_{si} - R_s)B_g$. Name all the notations used in both equations with proper units. [20M]
- ii. The Big Butte field is a combination-drive reservoir. The current reservoir pressure is estimated at 2500 psi. The reservoir production data and PVT information are given below:

	Initial reservoir condition	Current reservoir condition
p, psi	3000	2500
B_o , bbl/STB	1.35	1.33
R_s , scf/STB	600	500
N_p , MMSTB	0	5
G_p , MMMscf		5.5
B_w , bbl/STB	1.00	1.00
W_e , MMbbl	0	3
W_p , MMbbl	0	0.2
B_g , bbl/scf	0.0011	0.0015
c_f, c_w	0	0

The following additional information is available:

Volume of bulk oil zone = 100,000 ac-ft

Volume of bulk gas zone = 20,000 ac-ft

Calculate initial oil in place.

[10M]



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Max Marks: 40

Max Time: 60 Mins

Weightage: 20 %

TEST 2

I Semester 2017-2018

Course: **PET 209 Reservoir Engineering - 1**

27-10-2017

Instructions:

- i. Write legibly
- ii. For Z value use the table

Part A

(5Q x 4M= 20 Marks)

1. a) Write capillary pressure equation for air water system with its terms.
b) What will be oil water contact depth in ft if the free water level is 5000ft, displacement pressure is 1.5 psi when oil and water densities are 50 and 65 lb/ft³?
2. Draw a neat sketch of oil-wet and water-wet rocks relative permeability curves.
3. Define the following
 - a) Critical point
 - b) Cricondentherm
 - c) Cricondenbar
 - d) Shrinkage
4. What are the usual experiments and calculations in complete PVT analysis for oil?
5. a) Name the three groups of reservoir fluids classified based on isothermal compressibility coefficient. Show schematic illustrations of the volume changes as a function of pressure for the three types of fluids.
b) What are the basic three types of flow regimes that must be recognized in order to describe the fluid flow behavior and reservoir pressure distribution as a function of time? Show a schematic comparison of the pressure declines as a function of time of the three flow regimes.

Part B

(2Q x 10M= 20 Marks)

6. Natural gas is present in a reservoir at 155°F and pressure of 2000psi, what will be its gas formation volume factor in ft^3 / scf and gas expansion factor in scf/bbl for following gas composition?

Component	Mole Fraction	Critical Temperature (°R)	Critical Pressure (psi)
C1	0.85	345	667
C2	0.09	550	710
C3	0.04	665	615
C4	0.02	765	550

7. A linear porous media is flowing a 0.72 specific gravity natural gas at 133°F. The upstream and downstream pressures are 2100 psi and 1894 psi, respectively. The cross-sectional area is constant at 4500 ft². The total length is 762 meter with an absolute permeability of 0.060 Darcy. Calculate the gas flow rate in scf/day if viscosity is 0.0173cp.

Z - Table

Pseudo Reduce Temperature (T_{pr})	Pseudo Reduce Pressure (P_{pr})	Compressibility Factor (Z)
1.3	2.9	0.74
1.4	2.9	0.78
1.5	2.9	0.81
1.6	2.9	0.83
1.7	2.9	0.86
1.3	3	0.75
1.4	3	0.79
1.5	3	0.82
1.6	3	0.84
1.7	3	0.87
1.3	3.1	0.76
1.4	3.1	0.8
1.5	3.1	0.83
1.6	3.1	0.85
1.7	3.1	0.88



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TEST 1

I Semester 2017-2018

Course: **PET 209 Reservoir Engineering - 1**

16 SEPT 2017

Instructions:

- i. Write legibly
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Part A

(10Q x 2 M= 20 Marks)

1. Define Contingent Resources.
2. What are the factors affecting level of uncertainty in reserve estimation?
3. What information of rock can be obtained by RCAL and SCAL?
4. Define absolute porosity and write its equation in terms of interconnected, dead -end and isolated pores.
5. Write mathematical Equations used for averaging porosity by thickness weighted average form and Volumetric Weighted average form with notations
6. Write Darcy's equation for inclined or dipping flow system.
7. When is a porous medium said to have a permeability of one Darcy?
8. What is the effect of pressure and temperature on surface tension?
9. Name the factors which affect reservoir wettability
10. Define Critical Oil Saturation

Part B

(2 Q x 5 M= 10 Marks)

11. Schematically illustrate and summarize the Klinkenberg's effect for absolute permeability measurement using gases
12. A 10cP viscosity oil is being produced from a 150 acre drainage area where the average pressure is 2000psi. The radius of the wellbore is 4.5inch the thickness of the pay zone is 20ft, and the bottom hole flowing pressure is 1250psi. The formation permeability is 100mD. Calculate oil flow rate for a positive skin effect of 5, assuming steady-state radial flow. (1 acre = 43560 ft²)

Part C

(1 Q x 10 M= 10 Marks)

- 13. Given the following data for North Sea oil field**

Area = 26,700 acres

Net productive thickness = 49 ft

Porosity = 8%

Average $S_{wi} = 45\%$

Initial reservoir pressure, $p_i = 2580$ psi

Abandonment pressure, $p_a = 500$ psi

B_o at $p_i = 1.68$ bbl/STB

B_o at $p_a = 1.15$ bbl/STB

S_g at $p_a = 34\%$

S_{or} after water invasion = 20%

Calculate:

- I. Initial oil in place
- II. Oil in place after volumetric depletion to abandonment pressure
- III. Oil in place after water invasion at initial pressure
- IV. Oil reserve and Recovery Factor by volumetric depletion to abandonment pressure
- V. Oil reserve and Recovery factor by full water drive