Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Winter Semester: 2021 - 22

Course Code: PET 225

Course Name: Advanced Reservoir Engineering and Management

Program & Sem: B.Tech & VI Semester

Date: 26th April /2022

Time: 10:00 AM to 11:00 AM

Max Marks: 30

Weightage: 15 %

Instructions:

(i) Read all the questions carefully and answer accordingly.

(ii) Question paper consists of three parts: Part A, Part B and Part C.

(iii) Attempting all the questions is mandatory.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries THREE marks. (4 Q x 3 M = 12 M)

Q.NO. 1. What are the different flow regimes that affect the water influx into the reservoir? (C.O.No.1) [Knowledge]

Q No. 2. Through an illustration of a reservoir-aquifer system, discuss the classification of aquifers based on the reservoir geometry? (C.O.No.1) [Knowledge]

Q No. 3. Classify the different types of aquifers based on the dimensions of their boundary and explain them in terms of pressure changes at the reservoir-aquifer boundary? (C.O. No 1) [Knowledge]

Q No. 4. List the characteristic properties of the aquifer that is required for calculating the water influx into the reservoir? (C.O. No 1) [Knowledge]

How can one obtain the aquifer characteristics for use in the water influx modelling?

Part B [Thought Provoking Questions]

Answer the Question. Question carries EIGHT marks. (1Q x 8M = 8M)

Q.NO. 5. Suppose you are working for a petroleum engineering company XYZ and you are assigned a role to provide estimates of the water influx into a reservoir from the surrounding aquifer after careful assessment of the possible oil-water boundary conditions. Assume there are two scenarios, where the scenario 1 consists of an aquifer which is flowing under conditions of changing pressure at every location in the aquifer with time, i.e. the pressure throughout the aquifer changes with time. The scenario 2 consists of an aquifer which is having negligible dimensions compared to that of hydrocarbon reservoir, and assume the aquifer is radial and the fractional encroachment angle is ‘f’.

You must provide details of the water influx modelling in both the scenarios including water influx calculations. Also give the limitations of the modelling approach for both the scenarios.

(C.O.No.1) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. Question carries TEN marks. (1Q x 10M = 10M)

Q.NO. 6. Consider a water drive oil reservoir, where the aquifer is flowing under the steady state conditions. [10M] (C.O. No. 1) [Application]

Following data is provided for the pressure and fluid properties of the reservoir-aquifer system

Pi = 4000 psi
P = 3500 psi
Qo = 35,000 STB/day
Bo = 1.4 bbl/STB
GOR = 900 scf/STB
Rs = 700 scf/STB
Bg = 0.00082 bbl/scf
Qw =0
Bw = 1.0 bbl/STB

(a) Give an account of the rate at which the water will influx into the reservoir and determine the associated water influx constant from the above given data at the given single pressure drop condition

(b) Give an account of the total influx from the given aquifer into the reservoir upto 300 days (from initial) and at every 100 days interval. The following pressure-time data is given for the aquifer, assuming the Schilthuis' water influx constant to be 150 bbl/day/psi.

Time, days	Pressure, psi
0	4000 (Pi)
100	3900
200	3800
300	3700

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SCHOOL OF ENGINEERING

TEST 2

Winter Semester: 2021 - 22

Course Code: PET 225

Course Name: Advanced Reservoir Engineering and Management

Program & Sem: B.Tech VI Semester

Date: 1st June 2022

Time: 10:00 AM -11:00 AM

Max Marks: 30

Weightage: 15 %

Instructions:

(i) Read all the questions carefully and answer accordingly.

(ii) Question paper consists of three parts: Part A, Part B and Part C.

(iii) Use normal graph paper for Part C question, and tie the plotted graph paper inside the answer sheet.

(iv) Attempting all the questions is mandatory.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries THREE marks. (4Qx3M=12M)

(C.O. No. 2) [Knowledge]

Q.NO.1.What is primary recovery, secondary recovery and tertiary recovery of hydrocarbons. Gives examples for each recovery types? **(C.O. No. 2) [Knowledge]**

Q No.2.List the factors affecting the selection of a reservoir for waterflooding. Explain briefly any two factors? **(C.O. No. 2) [Knowledge]**

Q No.3.What is mobility ratio of reservoir fluids and how it affects the displacement of hydrocarbons?

(C.O. No. 2) [Knowledge]

Q NO.4. List and illustrate the different types of regular waterflood injection patterns. How do they differ from Peripheral waterflood injection pattern? **(C.O. No. 2) [Knowledge]**

Part B [Thought Provoking Questions]

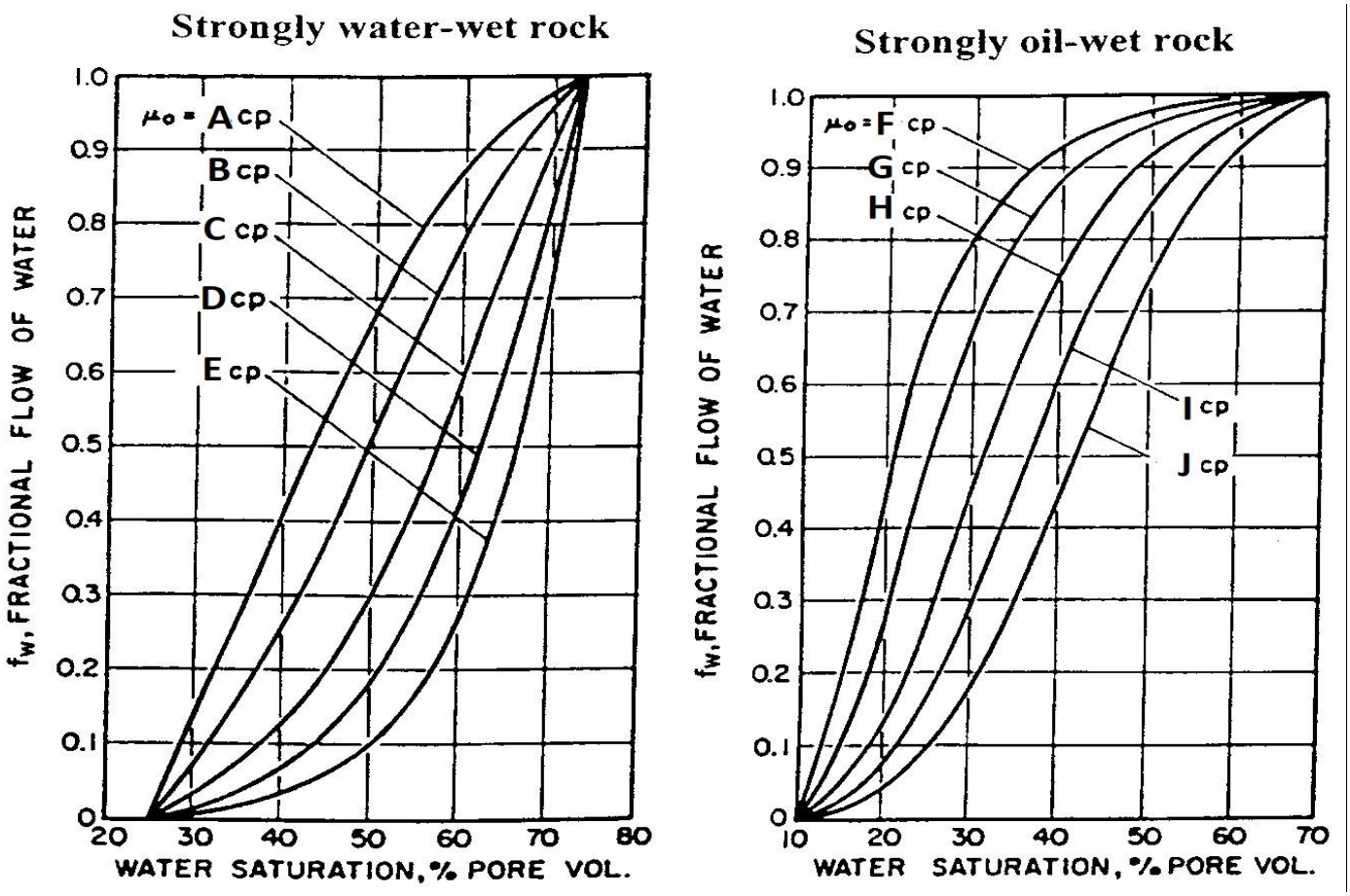
Answer the Question. Each question carries EIGHT marks. (1Q x 8M = 8M)

Q.NO.5. It is usually observed that wetting characteristics of a reservoir affect the hydrocarbon recovery and the fractional flow of water. Suppose you are working as a reservoir engineer and you are provided with below given fractional flow curves for oil-wet rock systems and water-wet rocks. The fractional flow curves of both water wet and oil-wet rock systems exhibit variations with changing oil viscosities. The viscosity of the different curves are labelled as A, B, C, D and E for the strongly

water wet systems. Similarly, the viscosity curves are labelled as F, G, H, I and J for the strongly oil-wet systems.

You must report the viscosity curves in the decreasing order for both the cases, and then give an account of how these oil viscosities will affect the fractional flow of water and the hydrocarbon recovery?

Why the fractional flow profiles are different for strongly water-wet and strongly oil-wet systems shown in the below figure? . **(C.O. No. 2) [Comprehension]**



Part C [Problem Solving Questions]

Answer the Question. The question carries TEN marks. (1Q x 10M = 10M)

Q.NO. 6. Give an account of the fractional flow using the below given relative permeability curve for a linear reservoir system. Following properties are given for the reservoir system.

Dip angle = 0

Density of oil (ρ_o) = 45 lb/ft^3

Oil formation volume factor (B_O) = 1.2 bbl/STB

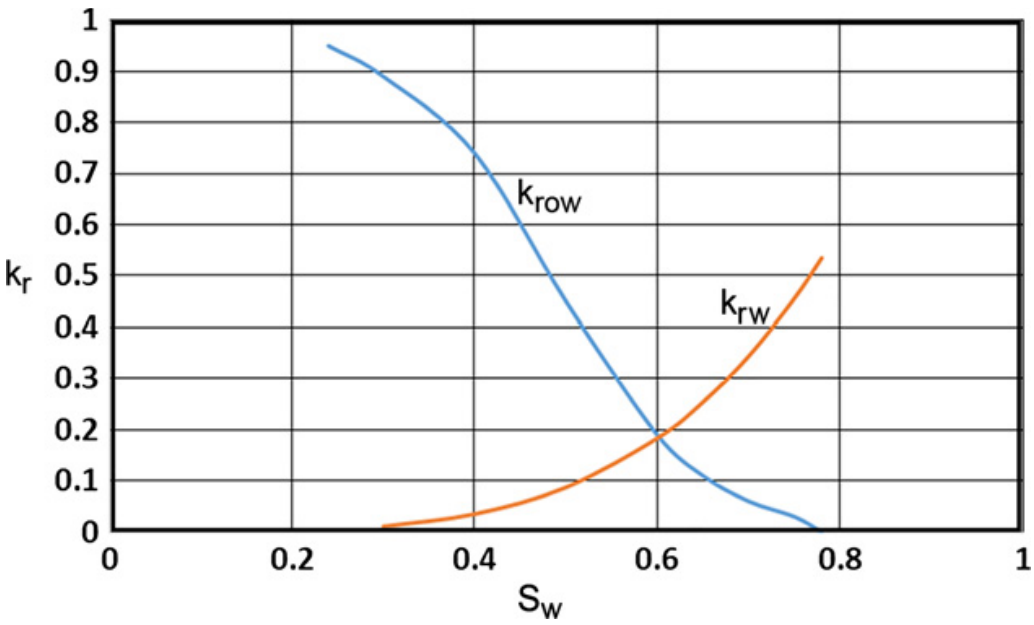
Water formation volume factor (B_w) = 1.05 bbl/STB

Viscosity of water (μ_w) = 0.5 cP

Absolute Permeability = 50 mD

Density of water (ρ_w) = 64 lb/ft^3

Perform the calculations for the following values of oil viscosity: μo = 0.5, 1 and 10 cP respectively. Use the below relative permeability graph to plot the fractional flow curves corresponding to different viscosities? Use normal graph paper for plotting.



Comment on which fraction flow curves (μo = 0.5, 1 or 10 cP) will be the most desirable for hydrocarbon production? **(C.O. No. 2) [Application]**

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END TERM EXAMINATION

Winter Semester: 2021 - 22
Course Code: PET 225
Course Name: Advanced Reservoir Engineering and Management
Program & Sem: B.Tech VI Sem

Date: 29th June 2022
Time: 09:30 AM to 12:30 PM
Max Marks: 100
Weightage: 50%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of three parts: Part A, Part B and Part C
(iii) Attempting all questions is mandatory. Some questions contains multiple parts.
(iv) *Use normal graph paper for Part C question, and tie the plotted graph paper inside the answer sheet.*

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries FOUR marks. (5Q x 4M = 20M)

1. List the essential properties and conditions to consider while deciding the optimal timing of waterflooding. How does the viscosity of the reservoir oil affects the flooding efficiency. How much free gas present in reservoir is suitable for the water and gas injections projects?
(C.O. No. 2) [Knowledge]

2. What is the primary reason behind influx of water into the hydrocarbon reservoir. Detail all the conditions leading to the water influx through diagrammatic approach?
(C.O. No. 1) [Knowledge]

3. Define the instantaneous GOR of a depletion drive reservoir. Express it mathematically in terms of fluid and rock properties with proper nomenclature. (C.O. No. 3) [Knowledge]

4. What is an Absolute Open Flow (AOF) Potential in an inflow performance relationship of a well? Mark AOF in the IPR curve. Can we measure the AOF in real conditions?
(C.O. No. 3) [Knowledge]

5. Briefly detail about the following terms with details about their formation conditions.

a. Stable Cone (C.O. No. 4) [Knowledge]
b. Unstable Cone
c. Critical Production Rate

Part B [Thought Provoking Questions]

Answer both the Questions. Each question carries TWENTY marks. (2Q x 20M = 40M)

6. Prediction of future reservoir performance is essential to determine the economic potential of an oilfield. The material balance equation is often used to provide the estimates of the initial oil in place, size of gas cap and water influx. But to use the material balance equation for performance prediction, it is essential to determine the instantaneous gas-oil ratio (GOR). Thus, understanding of instantaneous GOR is highly important. Keeping this in mind, provide your understanding of the GOR curve (Fig. 1) of a given hypothetical depletion drive reservoir shown below, where well flowing pressure is plotted against time or cumulative oil. Provide your understanding for the following points given below:

1) How the GOR varies at the points **1, 2, 3, 4 and 5.**

2) Gas saturation curve

3) Well Flowing Pressure Curve (C.O. No. 3) [Comprehension]

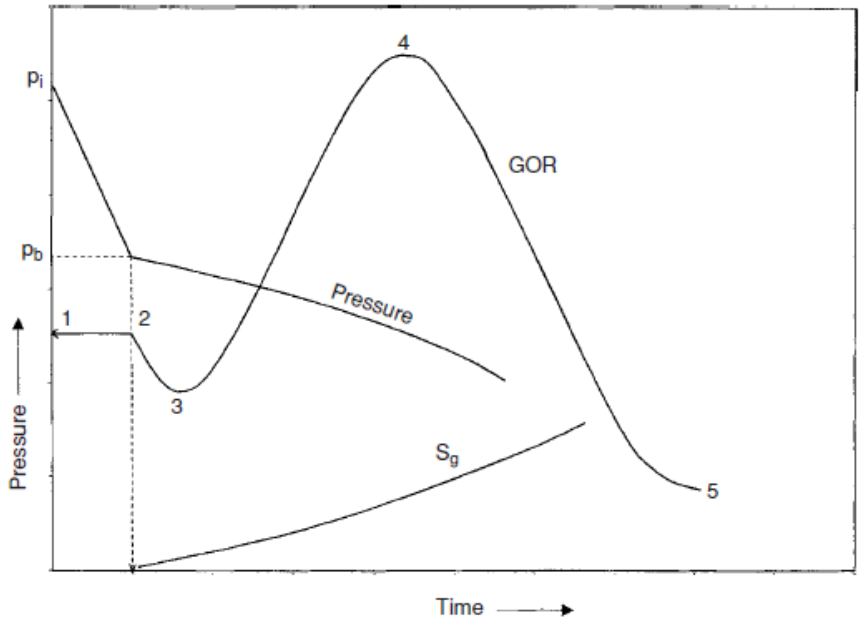

Fig 1. Characteristics of Solution Gas/Depletion Drive Reservoir

7. **A.** Overall recovery efficiency of hydrocarbons is determined considering the displacement in all possible directions. Provide your understanding of the overall recovery efficiency in terms of different efficiency factors, and detail the major factors affecting them. Also give brief details about displacement efficiency of waterflooding? (C.O. No 2) [Comprehension]

B. In order to develop an approach to calculate the increase in average water saturation in the swept area. Buckley and Leverett (1942) developed a well established theory called the frontal displacement theory. Give your understanding about the fractional flow of water in an oil reservoir? Highlight its significance on waterflooding by illustrating through the relative permeability curve and fractional flow curve (for an oil reservoir). (C.O. No 2) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each question carries TWENTY marks. (2Q x 20M = 40M)

8. **A.** Using the relative permeability curve (Fig. 2) given below, plot the fractional flow curve on a graph paper for a dipping reservoir system under the waterflooding. The water injection rate in waterflooding is 1000 bbl/day. The oil viscosity is considered constant at 1 cP. Calculate the fractional flow curve for the reservoir dip angles of 10^o and 20^o, assuming

(a) updip displacement

(b) downdip displacement. (C.O. No. 2) [Application]

Viscosity of water (μ_w) = 0.5 cP
Density of water, ρ_w = 64 lb/ft^3
Water formation volume factor B_w = 1.05 bbl/STB
Cross sectional Area A= 25,000 ft ^{2}

Absolute Permeability = 50 mD
Oil formation volume factor B_O = 1.2 bbl/STB
Density of oil (ρ_o) = 45 lb/ft^3

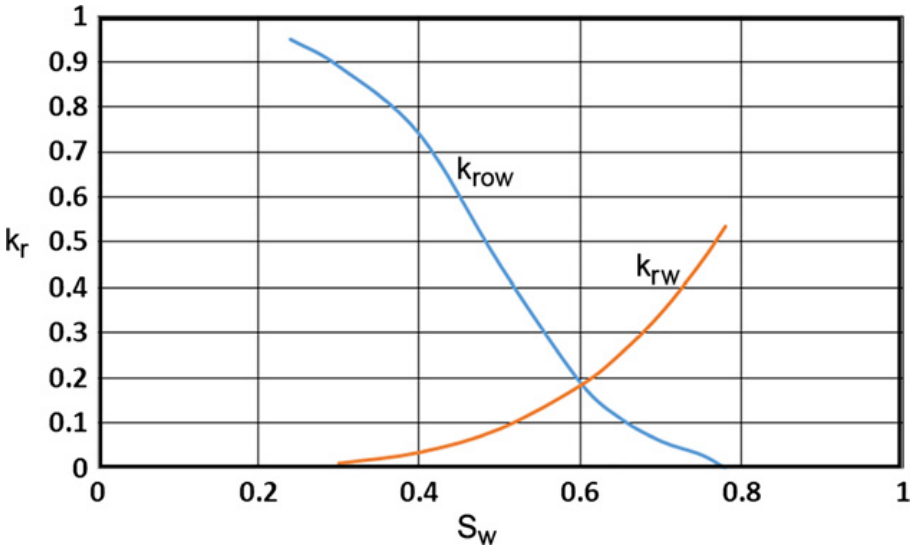

Fig 2. Relative permeability data

B. Explain the variation in the relative permeability curves of oil and water with respect to water saturation in the **Fig. 2** given above? Provide the values of the residual oil saturations and connate water saturations in Fig. 2? (C.O. No. 2) [Application]

9. **A.** Provide your understanding about the phenomena of simultaneous water and gas coning in an oil well? Does the coning depends on viscosity and rapidity of the reservoir fluids (water and gas)? Briefly state any technique to eliminate the coning phenomena.

(C.O. No. 4) [Application]

B. A vertical well is drilled in an oil reservoir that is overlaid by a gas cap and underlaid by a vertical well is drilled in an oil reservoir overlaid by a gas cap. The related well and reservoir data are given as follows:

oil density, ρ_o = 47.5 lb/ft^3

water density = 63.76 lb/ft^3

gas density, ρ_g = 5.1 lb/ft^3

oil viscosity, μo = 0.73 cp

oil formation volume factor, Bo = 1.1 bbl/STB

oil column thickness, h = 65 ft

well 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

Oil effective permeability, Ko= 93.5 md

Horizontal and vertical permeability .i.e. Kh= 110 md, Kv= 110 md

Oil relative permeability, Kro= 0.85

Using the above data determine the maximum permissible oil rate that can be imposed to avoid cones breakthrough .i.e water and gas coning? (C.O. No. 4) [Application]

C. Is coning phenomena avoidable in oil and gas production and if it is avoidable, should it be avoided during oilfield life? Give your brief insights on this statement? (C.O. No. 4) [Application]