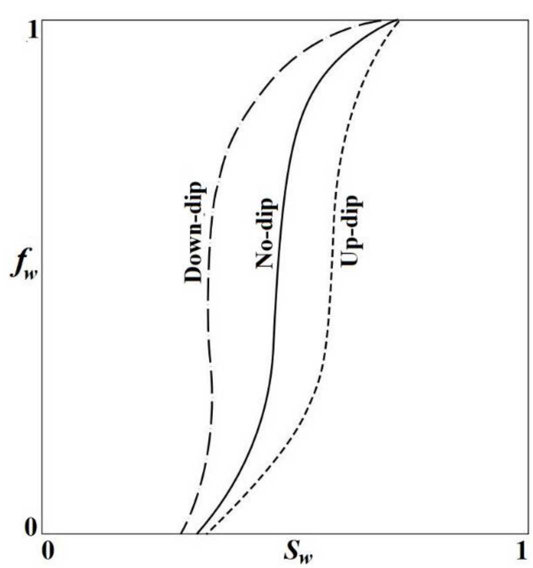
Name: **Enrolment No:**	

UPES
End Semester Examination, May 2023

Course: Advanced Reservoir Engineering — **Semester: II**
Program: M. Tech (PE) — **Time : 03 hrs.**
Course Code: PEAU 7017 — **Max. Marks: 100**

Instructions: All questions are compulsory.

SECTION A
(4Qx5M=20Marks)

S. No.		Marks	CO
Q1.	List briefly the classification of aquifers.	**5**	**CO1**
Q2.	The plot of water fractional flow against water saturation can be seen in the following figure. Indicate the case that has the best mobility ratio and provide justifications for your selection.  	**5**	**CO2**
Q3.	The degree of vertical permeability variation influences the vertical sweep efficiency. Explain this statement for a layered reservoir, which has been taken up for water injection.	**5**	**CO1**

Q4.	An oil well is tested at a flow rate (Q) of 50 BOPD. The bottom hole flowing pressure (Pwf) is 500 psia. The shut-in pressure is 1000 psia. If P_{wf} is lowered to 300 psia and assuming the Vogel's correlation holds, find the estimated flow rate in the oil well.	**5**	**CO2**
SECTION B (4Qx10M= 40 Marks)			
Q5.	Illustrate with the help of a diagram how the gas-oil ratio changes as the reservoir pressure varies in a hypothetical depletion-drive reservoir.	**10**	**CO3**
Q6.	An active water drive oil reservoir is producing under the steady-state flowing conditions. The following data is available: P_i = 4000 psi, Q_w = 0, R_s = 500 scf/STB, Q_o = 40,000 STB/day, P = 3000 psi, T = 140°F, GOR = 700 scf/STB, B_o = 1.3 bbl/STB, B_w = 1.0 bbl/STB, z = 0.82. Calculate Schilthuis' water influx constant.	**10**	**CO3**
Q7.	Summarize the flooding patterns that should be considered when designing a waterflooding project. Additionally explain the important factors that must be considered while making the selection of injection pattern.	**10**	**CO2**
Q8.	An oil well is producing under steady-state flow conditions at 300 STB/day. The bottom-hole flowing pressure is recorded at 2500 psi. Given: h = 23 ft, k = 50 md, μ_o = 2.3 cp, r_w = 0.25 ft, B_o = 1.4 bbl/STB, r_e = 660 ft, s = 0.5. Calculate: a) Reservoir pressure b) AOF c) Productivity index Or An oil well is producing from an undersaturated reservoir that is characterized by a bubble-point pressure of 2130 psig. The current average reservoir pressure is 3000 psig. Available flow test data shows that the well produced 250 STB/day at a stabilized p_{wf} of 2500 psig. Construct the IPR data.	**10**	**CO3**
SECTION-C (2Qx20M=40 Marks)			
Q9.	Plot the fractional flow curve for a linear reservoir system with the following properties: Dip angle = 0, Absolute permeability = 50 md, B_o = 1.20 bbl/STB, B_w = 1.05 bbl/STB, ρ_o = 45 lb/ft^3, ρ_w = 64.0 lb/ft^3, μ_w = 0.5 cp, Cross-sectional area A = 25,000 ft^2. (Use the relative permeability curve as shown in Figure 1 for necessary calculations). Perform the	**20**	**CO4**

	calculations for the following values of oil viscosity: μ_o = 0.5, 1.0 and 5cp.		

Q10. (20) **CO4**

An oil well is producing from an undersaturated reservoir that is characterized by a bubble-point pressure of 2130 psig. The current average reservoir pressure is 3000 psig. Available flow test data shows that the well produced 250 STB/day at a stabilized p_{wf} of 2500 psig.

a. Construct the IPR data.
b. The well was retested and the following results obtained: P_{wf} = 1700 psig, Q_o = 630.7 STB/day. Generate the IPR data using the new test data.

Or

Calculate the water influx as a function of time for the following reservoir-aquifer and boundary pressure data: p_i = 2740 psi, h = 100 ft, c_t = 7×10^{-6} psi, μ_w = 0.55 cp, k = 200 md, θ = 140°, reservoir area = 40,363 acres and aquifer area = 1,000,000 acres. (Using fetkovich's method)

Time (Days)	Pressure (psi)
0	2740
365	2500
730	2290
1095	2109
1460	1949

Some important formulas:

$$W_i = \left[\frac{\pi\left(r_a^2 - r_e^2\right) h \phi}{5.615}\right]$$

$$W_e = (c_w + c_f)\, W_i\, f\, (p_i - p)$$

$$\frac{dW_e}{dt} = e_w = \left[\frac{0.00708\, kh}{\mu_w \ln\left(\frac{r_a}{r_e}\right)}\right](p_i - p)$$

$$e_w = \frac{dW_e}{dt} = B_o \frac{dN_p}{dt} + (GOR - R_s)\frac{dN_p}{dt} B_g + \frac{dW_p}{dt} B_w$$

$$e_w = \frac{dW_e}{dt} = \frac{0.00708\, kh\, (p_i - p)}{\mu_w \ln(at)}$$

$$t_D = 6.328 \times 10^{-3} \frac{kt}{\phi \mu_w c_t r_e^2}$$

$$B = 1.119\, \phi\, c_t\, r_e^2\, h$$

$$W_e = B\, \Delta p\, W_{eD}$$

$$z_D = \frac{h}{r_e \sqrt{F_k}}$$

$$(\Delta W_e)_n = \frac{W_{ei}}{p_i}\left[(\bar{p}_a)_{n-1} - (\bar{p}_r)_n\right]\left[1 - \exp\left(-\frac{J\, p_i\, \Delta t_n}{W_{ei}}\right)\right]$$

$$J = \frac{0.00708\, kh\, f}{\mu_w\, [\ln(r_D)]}$$

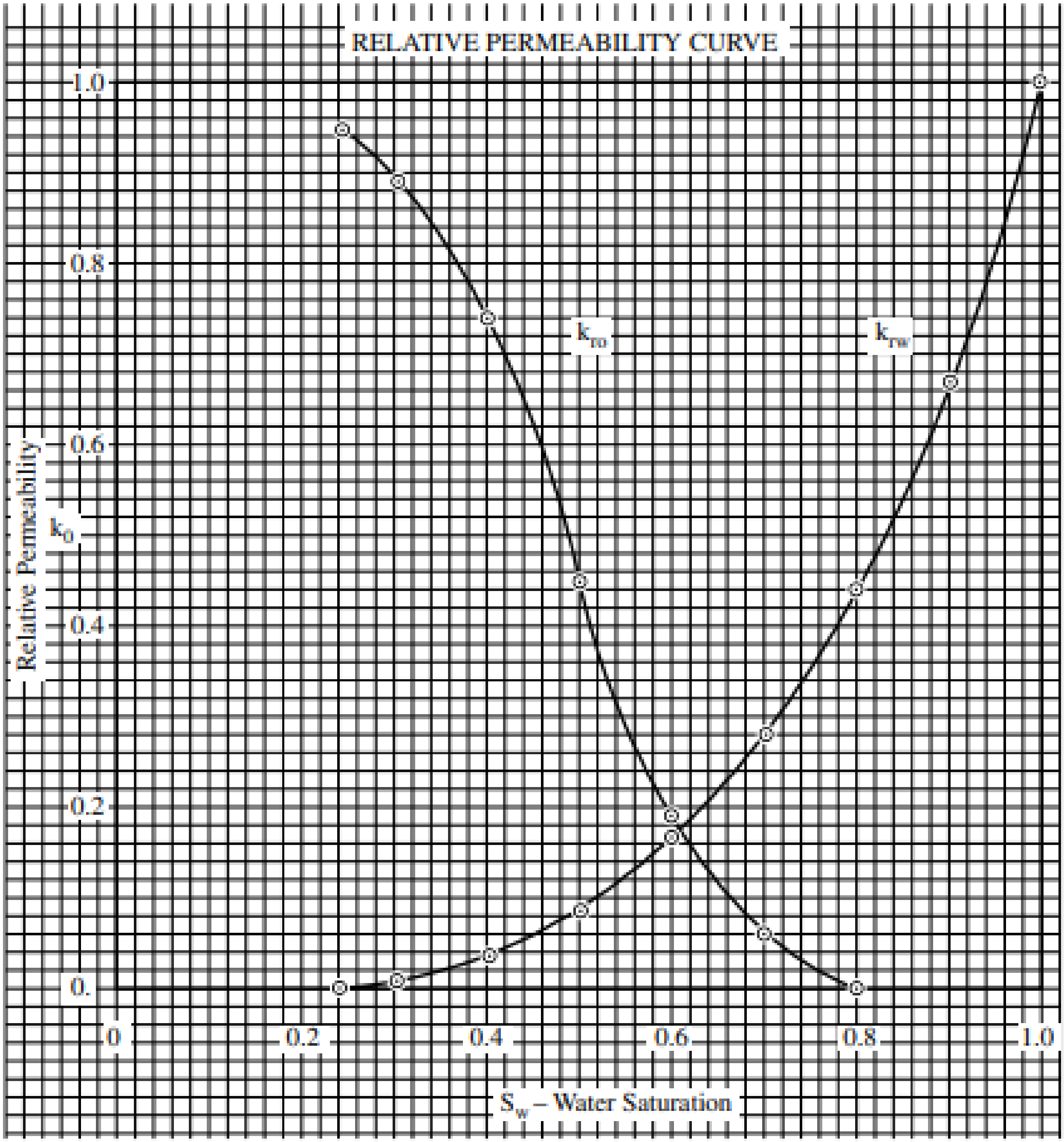


Figure 1. Relative permeability curve