Exercise 2

2.The linear system in exercise-1 is under consideration for a waterflooding project, water-injection rate i_w =1000 bbl/day, u_0 = 10 cp.

(1) Calculate the fractional flow for the reservoir dip angles of **10°, 20°, and 30°,**

assuming **(a) updip displacement** and **(b) downdip displacement.**

(2) What conclusions can you draw?

S_w	k_{ro}	k_{rw}	k_{ro}/k_{rw}	F_w , updip			F_w , downdip		
				10°	20°	30°	10°	20°	30°
0.24	0.95	0							
0.3	0.89	0.01							
0.4	0.74	0.04							
0.5	0.45	0.09							
0.6	0.19	0.17							
0.65	0.12	0.22							
0.7	0.06	0.28							
0.75	0.03	0.36							
0.78	0	0.41							

(**In field units**, the fractional flow equation can be expressed as:

$$f_w = \frac{1 + \left(\frac{0.001127 k_o A}{\mu_o q_t}\right)\left[\frac{\partial p_c}{\partial x} - 0.433 \Delta\rho \sin(\alpha)\right]}{1 + \frac{k_o}{k_w}\frac{\mu_w}{\mu_o}}$$

where f_w = fraction of water (water cut), bbl/bbl
k_o = effective permeability of oil, md
k_w = effective permeability of water, md
$\Delta\rho$ = water-oil density differences, g/cm^3
k_w = effective permeability of water, md
q_t = total flow rate, bbl/day
μ_o = oil viscosity, cp
μ_w = water viscosity, cp
A = cross-sectional area, ft^2

Noting that the relative permeability ratios $k_{ro}/k_{rw} = k_o/k_w$ and, for two-phase flow, the total flow rate q_t are essentially equal to the water-injection rate, i.e., $i_w = q_t$