National Exams May 2017

98-Pet-A6, Reservoir Mechanics

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit, with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM. Any non-communicating calculator is permitted.

3. The exam consists of EIGHT (8) questions. Candidate(s) should respond to 100 marks of their choice out of the total 120 marks (leave the space provided for the solutions for 20 marks blank).

4. Clarity and organization of the answer are important.

Question 1

Marks

A well with the parameters given below starts production at a constant rate of 1,000 STB/day.

r_e=1,000 ft	p_i=2,500 psi	r_w=4 in.
k=600 md	h=32 ft	Φ=0.15
μ_o=2 cp	c_t=12×10^{-6} psi^{-1}	B_o=1.333 res bbl/STB

5 a) Determine when the well becomes finite acting

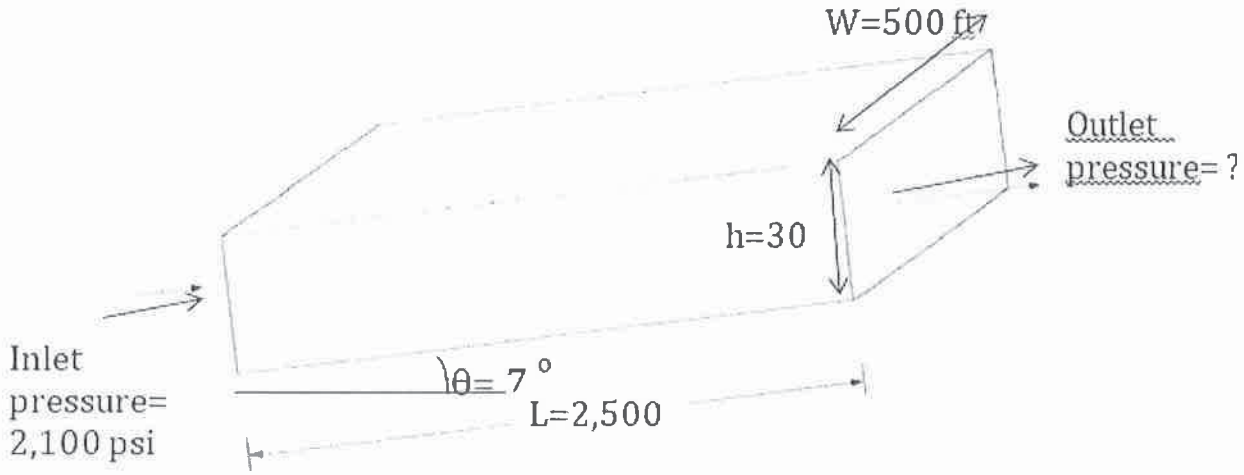
10 b) Calculate the pressure in the well after 1 and 48 hours of production.

Question 2

Marks

An incompressible fluid flows in a linear tilted porous media with the dip angle of 7° and the following properties:

k=60 md	ϕ=20%	μ=2 cp
Inlet pressure= 2,100 psi	Q= 5 bbl/day	ρ= 44 lb/cu ft

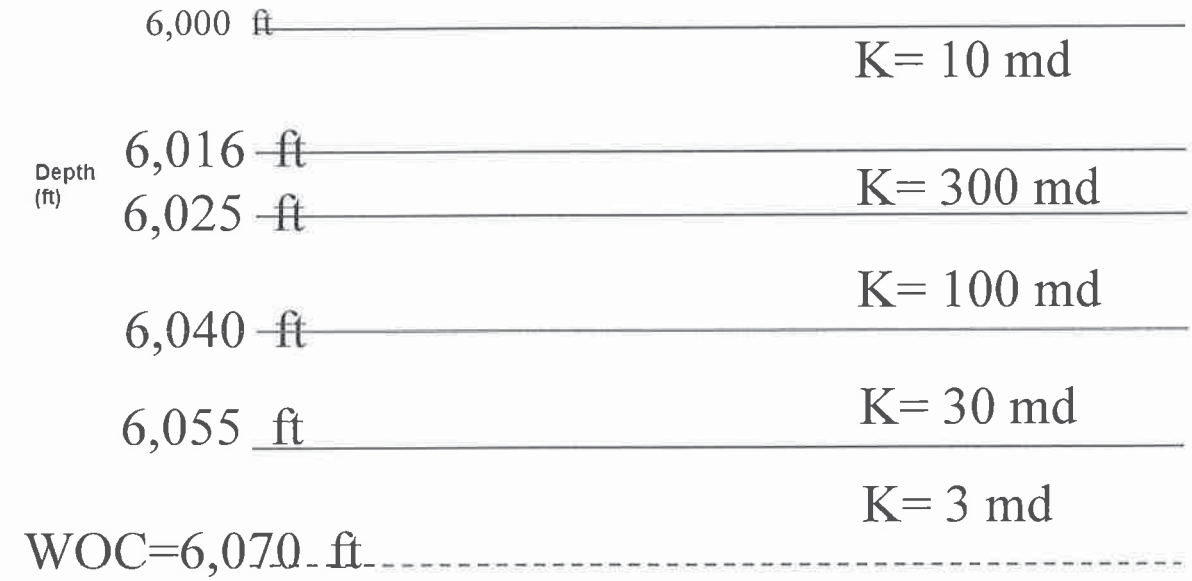


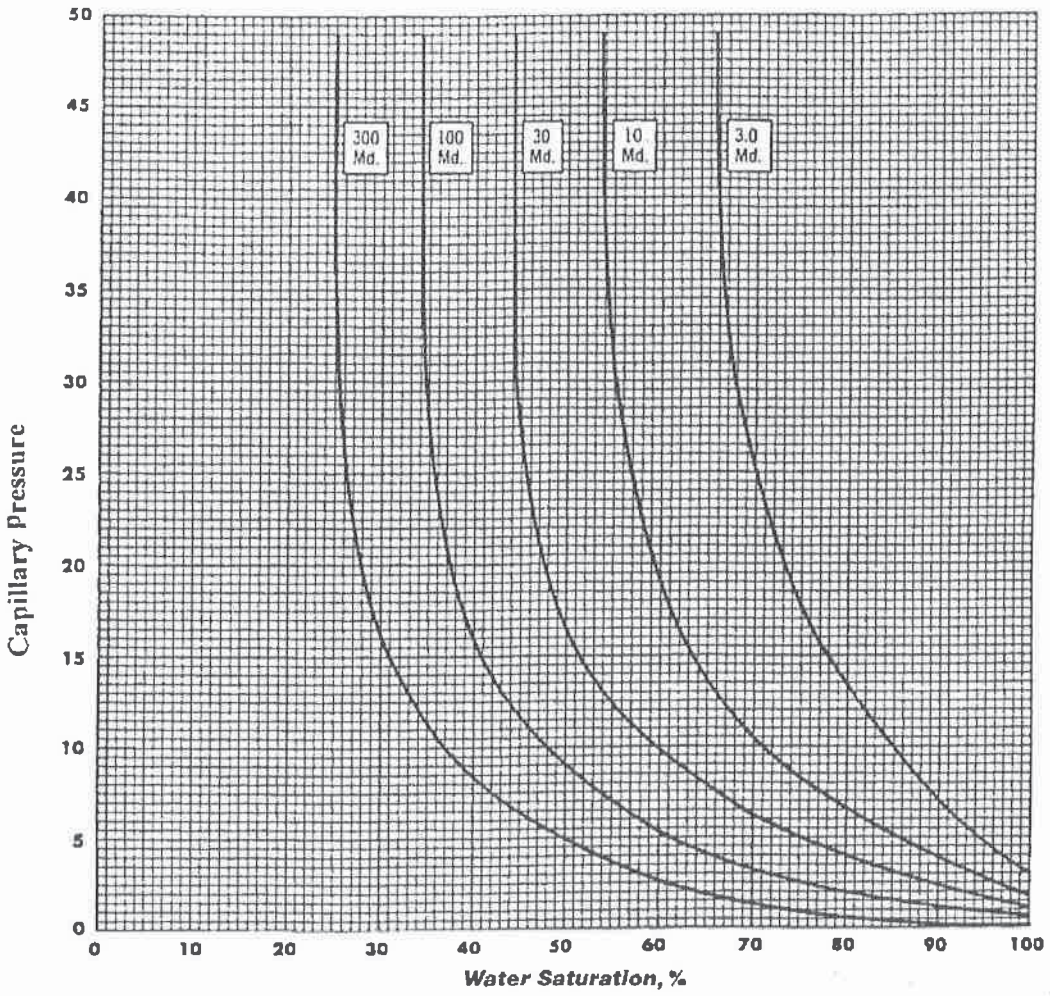
10 Calculate the outlet pressure.

Marks

A five-layer oil reservoir is characterized by a set of capillary pressure-saturation curves shown below. The following additional data are also available:

Water density= 66 lb/cu ft
Oil density= 35 lb/cu ft





5 a) Calculate the Free Water Level (FWL)

5 b) Calculate water saturation at depth=6,030 ft

Question 4

Marks

5 A confined reservoir with pore volume of one billion res bbl has been produced for 6 years at an average production rate of 10,000 STB per day. The reservoir pressure was 5,000 psi when the production began. Assuming an average total compressibility of 10^-5 psi^{-1} and average oil formation volume factor of 1.4 res bbl/STB during this period assess its current average reservoir pressure.

Question 5

Marks

The following data apply to an oil reservoir.

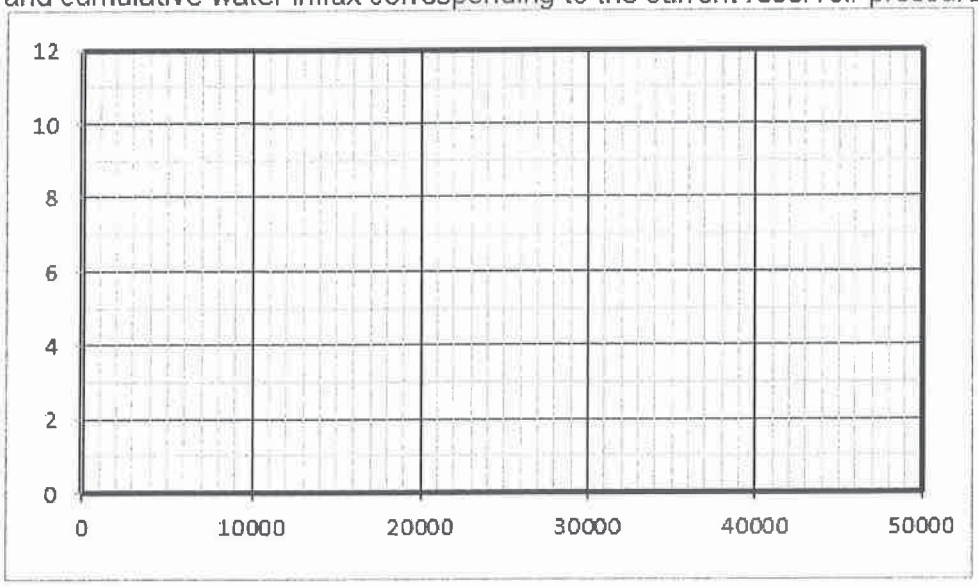
P (psia)	Bo (res bbl/STB)	Rs (scf/STB)	Bg (res bbl/scf)	Np (MMSTB)	Gp (MMscf)
3000	1.316	650		0.000	0.0
2500	1.324	650	0.00082	0.092	59.8
1500	1.252	510	0.00135	0.850	490.0
1300	1.231	450	0.00160	1.100	970.0

Reservoir saturation pressure is 2500 psi and the current reservoir pressure is 1300 psi. Connate water saturation is 20%. There has been no water production.

Additional data:

$c_o = 15\times10^{-6}$ psi^{-1} $c_f = 7\times10^{-6}$ psi^{-1} $c_w = 3\times10^{-6}$ psi^{-1}

10 Use straight-line solution for MBE along with the Pot model for water influx and evaluate OOIP and cumulative water influx corresponding to the current reservoir pressure.

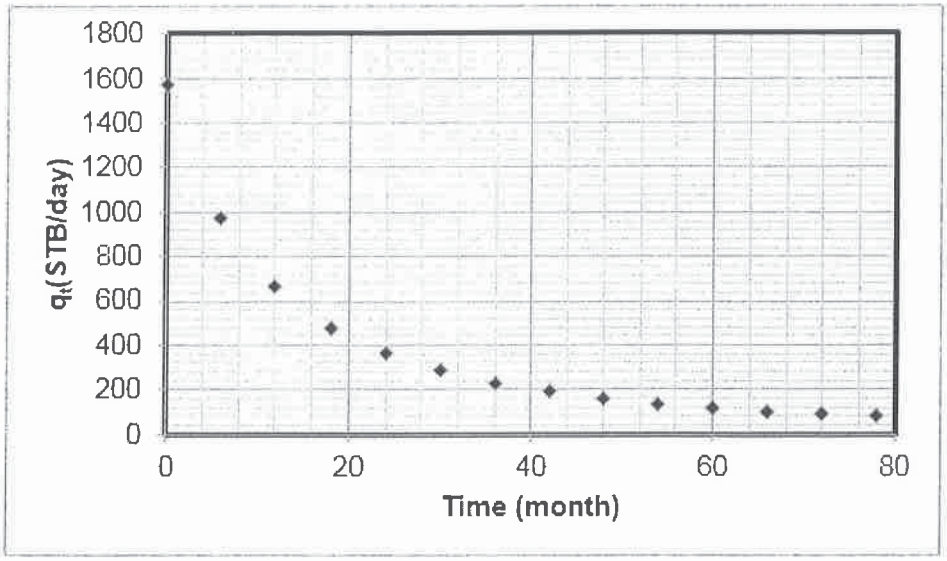


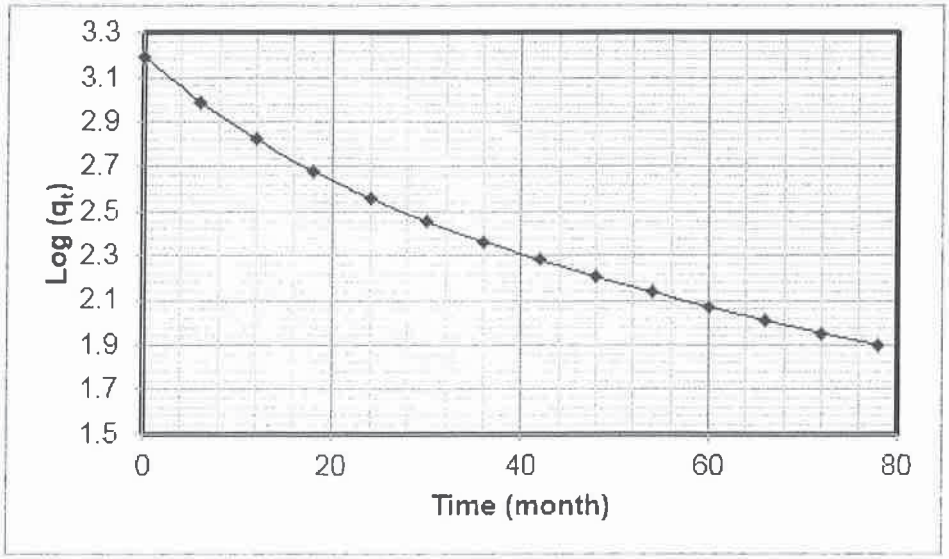
Question 6

Marks

The production history for a well is given in the table and figures below.

Date	Time (month)	Production rate (STB/day)
7/1986	0	1,568
1/1987	6	970
7/1987	12	664
1/1988	18	478
7/1988	24	363
1/1989	30	285
7/1989	36	230
1/1990	42	191
7/1990	48	161
1/1991	54	137
7/1991	60	118
1/1992	66	103
7/1992	72	90
1/1993	78	80





10 a) Use Hyperbolic Decline Method and calculate the projected rate at the end of 1995 (9.5 years after the start of production).

10 b) Calculate the incremental cumulative production from 1/1992 to 12/1995 (Month 66 to Month 114).

Question 7

Marks

A waterflood is under consideration for a narrow "shoestring" reservoir that is 300 ft wide, 20 ft thick and 1,000 ft long. The reservoir is horizontal and has a porosity of 0.15 and an initial water saturation of 0.30, which is considered immobile.

It is proposed to drill a row of injection wells at one end of the reservoir and flood the reservoir by injecting water at a rate of 350 bbl/day. Viscosities of the oil and water are 2.0 and 1.0 cp, respectively. Relative permeability data corresponding to the displacement of oil by water are given below:

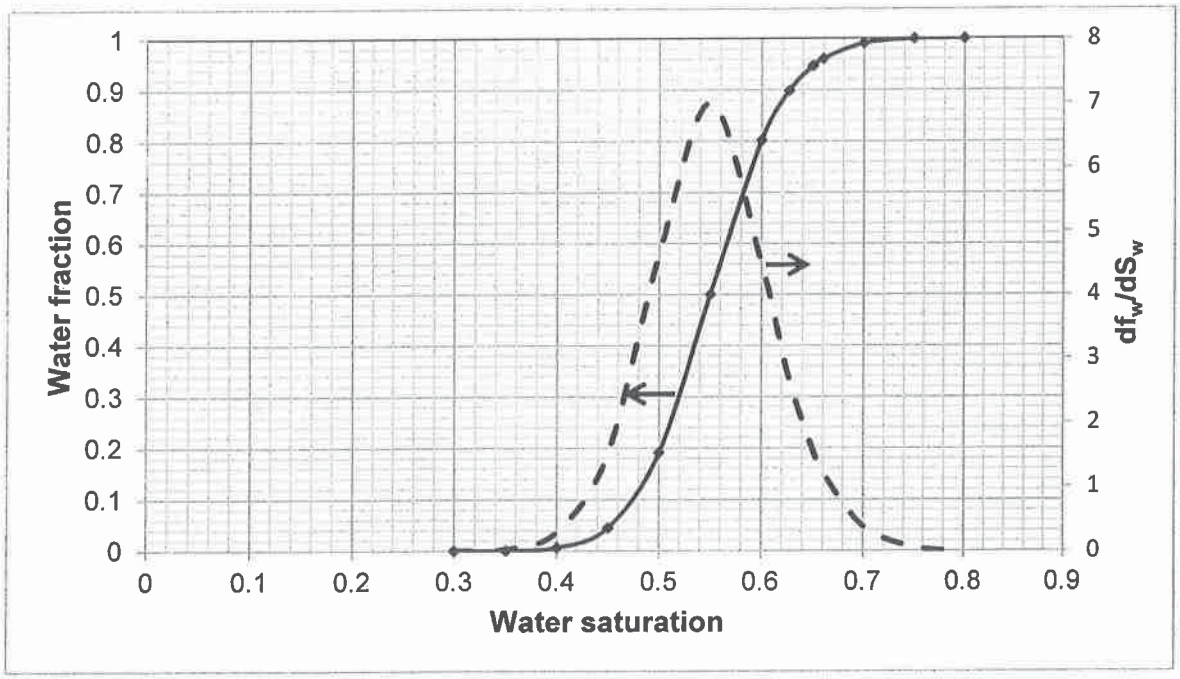
$$k_{ro} = (1 - S_{wD})^3$$

and

$$k_{rw} = (S_{wD})^4$$

$$S_{wD} = \frac{S_w - S_{wi}}{1 - S_{orw} - S_{wi}}$$

The residual oil saturation is 0.20. Oil and water formation volume factors are 1.0.



10 a) Estimate cumulative oil production when water saturation at the production wells is 66%

10 b) Estimate cumulative water production when water saturation in the production well is 66%.

10 c) Calculate areal sweep efficiency after injecting 25,000 bbl of water.

Question 8

Marks

A volumetric (no water influx) oil reservoir with an initial pressure of 3,100 psia and saturation pressure of 1,700 psia covers a 1,000 acres area. The reservoir has an average connate water saturation of 20%, an average porosity of 20% and a critical gas saturation of 5%.
The PVT data of the petroleum fluid at the reservoir temperature of 130 °F are listed below:

Pressure (psia)	B_o (res bbl/STB)	B_g (res bbl/scf)	R_s (scf/STB)	μ_o/μ_g
3,100	1.4500	-	900	
1,700	1.4733	0.0015	900	10.0
1,600	1.4404	0.0017	800	10.7

Additional data:

$c_o = 9\times10^{-6}$ psi^{-1} $c_f = 4\times10^{-6}$ psi^{-1} $c_w = 3\times10^{-6}$ psi^{-1}

h= 60 ft k= 100 md μ_w= 0.3 cp

The relative permeability ratio is formulated by $k_{rg}/k_{ro} = 0.005\exp(10.0S_g)$.

20 a) Predict the reservoir performance (N_p, G_p, R_p, S_o, GOR) after reservoir pressure declines to 1,600 psia.