UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
JANUARY 2017 SEMESTER

COURSE : **PCB4123 – ADVANCED WELL TEST ANALYSIS**

DATE :

TIME : **(3 HOURS)**

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions.
5. Do not open this Question Booklet until instructed.

Note : There are **EIGHT (8)** pages in this Question Booklet including the cover page and **APPENDIX**.

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FINAL EXAMINATION
JANUARY 2017 SEMESTER

COURSE : **PCB4123 – ADVANCED WELL TEST ANALYSIS**

DATE : **06th MAY 2017 (SATURDAY)**

TIME : **09:00 AM – 12:00 NOON (3 hours)**

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL FOUR (4)** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. Do not open this Question Booklet until instructed.

Note : There are **EIGHT (8)** pages in this Question Booklet including the cover page and **APPENDIX**.

1. a. i. Compare the signature of SS, SSS and USS flow regimes on a cartesian plot.

[6 marks]

ii. Formulate the wellbore storage coefficient by applying the material balance concept.

[6 marks]

b. i. Sketch the derivative plot with the relevant flow regimes for a non-fractured vertical oil well under draw-down test that is located between two asymmetric intersecting faults. Assume that the angle of intersection is 45 degrees and the wellbore storage effect is negligible.

[7 marks]

ii. Evaluate the accuracy of permeability calculation if a 45 degree intersecting faults flow regime is analyzed as radial flow by mistake.

[6 marks]

2. a. The draw-down data of a vertical fractured oil well are given in **TABLE Q2a**.

TABLE Q2a: Pressure transient data.

Time (hr)	Δp_{wf} (psi)
0.2	18.99
0.4	26.85
0.6	32.89
0.8	155.75
1	164.69
1.2	172.37

The reservoir and fluid data are given in **TABLE Q2b**.

TABLE Q2b: Reservoir and fluid data.

h (ft)	φ (%)	c_t (psi^{-1})	μ (cp)	B_o (RB/STB)	r_w (ft)	Q (STB/day)	k (md)
50	20	7.00E-06	0.65	1.15	0.3	100	1

i. Construct the log-log plot and show the available flow regimes.

[6 marks]

ii. Explain if the fracture is finite or infinite. Justify your answer.

[5 marks]

b. i. Analyze the linear flow regime using the specialized plot concept to obtain the fracture half-length (x_f).

[7 marks]

ii. Analyze the bi-linear flow regime using the specialized plot concept to obtain the fracture conductivity ($k_f w_f$).

[7 marks]

3. a. The diagram given in **FIGURE Q3** shows the structure of a reservoir that involves Well 1 and Well 2. The wells have intersected three sand bodies of A, B and C that are occupied by gas or water.

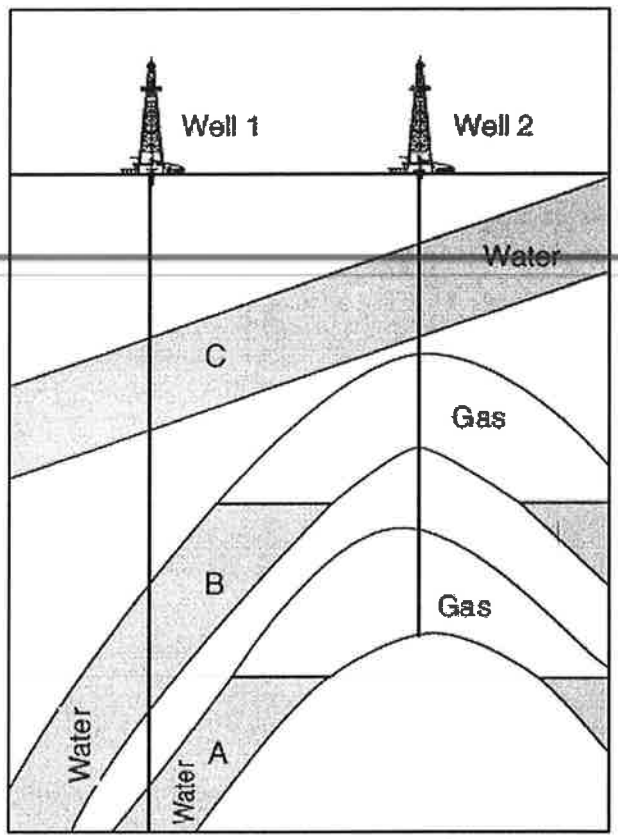

FIGURE Q3: Reservoir structure diagram.

Construct the corresponding depth versus pressure plot based on the RFT surveys of Well 1 and Well 2.

[7 marks]

b. Reconstruct the plot in **part (a)** if sand A is fully occupied by gas.

[6 marks]

c. Reconstruct the plot in **part (a)** if sand B is fully occupied by gas.

[6 marks]

d. Reconstruct the plot in **part (a)** if sand C is fully occupied by gas.

[6 marks]

4. a. The build-up pressure transient data of an oil reservoir are given in **TABLE Q4a**. The reservoir and fluid data are given in **TABLE Q4b**. The corresponding semi- log plot is shown in **FIGURE Q4**.

TABLE Q4a: Pressure transient data.

$\frac{t_p + \Delta t}{\Delta t}$	p_{ws} (psi)
358334	6644
129168	6650
64544	6654
32293	6661
16147	6666
8074	6669
4038	6678
2019	6685
1010	6697
506	6704
253	6712

TABLE Q4b: Reservoir and fluid data.

h_m (ft)	φ_m (%)	c_t (psi^{-1})	μ (cp)	B_o (RB/STB)	r_w (ft)	Q (STB/day)	k_m (md)	t_p (hr)
17	21	8.17E-06	1	2.3	0.375	2554	0.1	8611

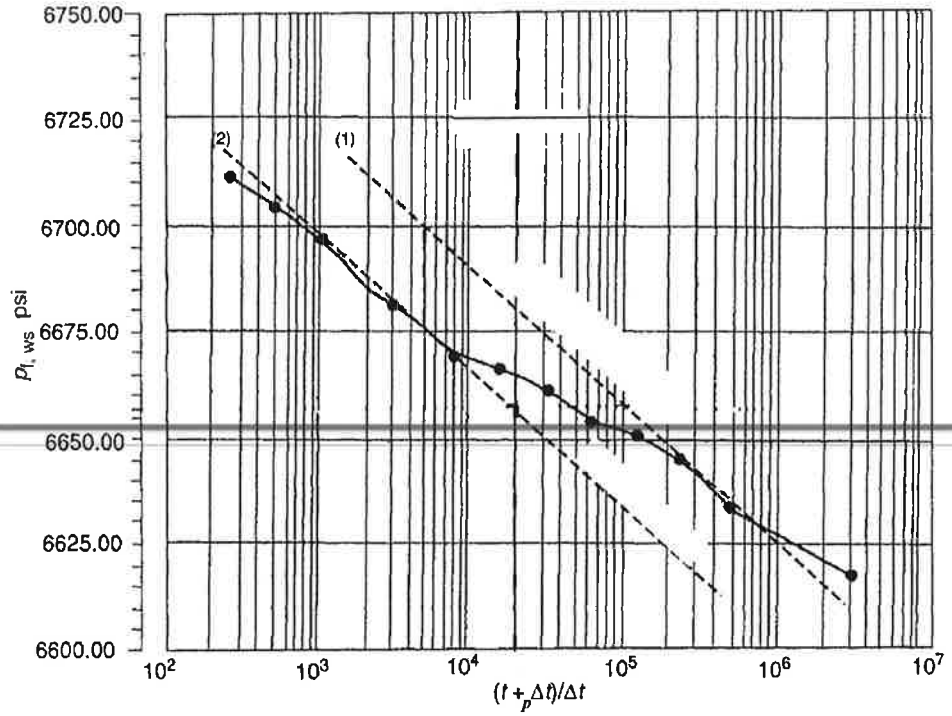

FIGURE Q4:Semi-log plot.

i. Analyze the semi-log plot to illustrate the signature of a naturally fractured reservoir.

[6 marks]

ii. Estimate the fracture permeability (k_f).

[5 marks]

iii. Estimate the storativity ratio (ω).

[7marks]

iv. Estimate the interporosity flow coefficient (λ).

[7 marks]

- END OF PAPER -

Linear flow:

$$p_{wD} = \sqrt{\pi t_D} + \overbrace{\frac{A}{\sqrt{F_{CD}}} + S}^{S_{apparent}}$$

F_{CD}	A
5	0.902
15	0.944
≥25	1.047

$$\Delta p_{wf} = \frac{4.06qB}{x_f h}\sqrt{\frac{\mu t}{k\phi c_t}} + \frac{141.2qB\mu}{kh}\left(\frac{A}{\sqrt{F_{CD}}} + S\right)$$

Bilinear flow:

$$p_{wD} = \frac{\pi}{\sqrt{2F_{CD}}}\frac{t_D^{1/4}}{0.9064025}$$

$$\Delta p_{wf} = \frac{44.1qB\mu}{h\left(k_f^2 w^2 k\varphi\mu c_t\right)^{1/4}} t^{1/4}$$

Naturally fractured reservoirs:

$$(k_f h) = \frac{162.6Q_o B_o \mu_o}{m}$$

$$\omega = 10^{(-\Delta p/m)}$$

In drawdown tests:

$$\lambda = \left[\frac{\omega}{1-\omega}\right]\left[\frac{(\phi h c_t)_m \mu r_w^2}{1.781 k_f t_1}\right] = \left[\frac{1}{1-\omega}\right]\left[\frac{(\phi h c_t)_m \mu r_w^2}{1.781 k_f t_2}\right]$$

In buildup tests:

$$\lambda = \left[\frac{\omega}{1-\omega}\right]\left[\frac{(\phi h c_t)_m \mu r_w^2}{1.781 k_f t_p}\right]\left(\frac{t_p + \Delta t}{\Delta t}\right)_1$$

or:

$$\lambda = \left[\frac{1}{1-\omega}\right]\left[\frac{(\phi h c_t)_m \mu r_w^2}{1.781 k_f t_p}\right]\left(\frac{t_p + \Delta t}{\Delta t}\right)_2$$