UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE	:	**PEB2073/PFB3013 - DRILLING ENGINEERING II**
DATE	:	**9 AUGUST 2024 (FRIDAY)**
TIME	:	**9:00 AM - 12:00 NOON (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, if any.
5. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **SEVEN (7)** pages in this Question Booklet including the cover page and appendices.

ii. **DOUBLE-SIDED** Question Booklet.

iii. Graph paper will be provided.

1. A typical build, hold and drop well trajectory is shown in **FIGURE Q1**. Given that the surface coordinates are (0 ft, 0 ft), the target coordinates are (3,500 ft, 4,800 ft). TVD of the production zone is 12,000 ft, the rate of build-up is 1.5°/100 ft, TVD of first deviation is 3,000 ft, the rate of drop-off is 1.5°/100 ft, TVD at the end of drop-off is 11,000 ft and the final inclination at target is 0 degree.

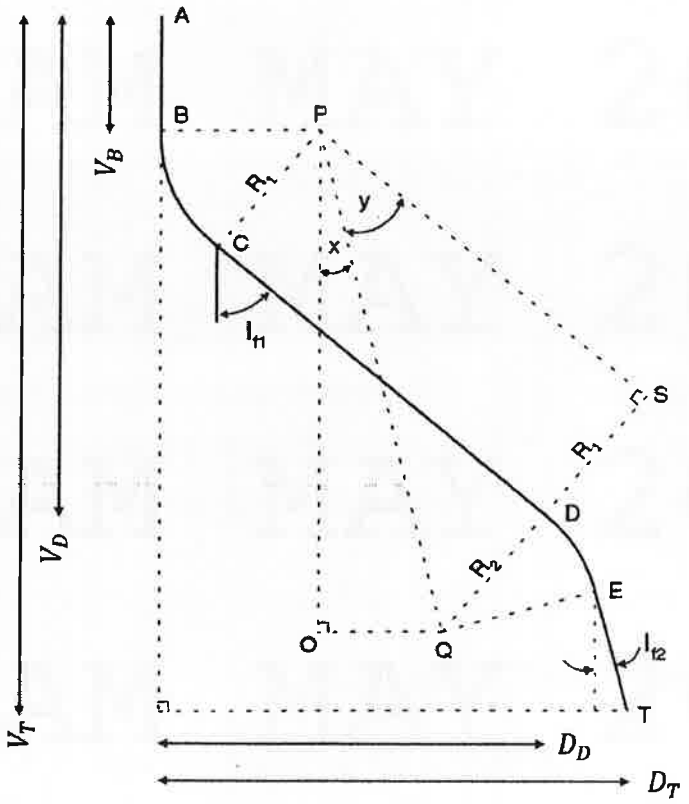

FIGURE Q1: Well profile

a. Calculate the horizontal departure, TVD and measured depth at point B, C, D, E and T and list all your assumptions.

[15 Marks]

b. Discuss the effect on the calculated measured depth if the build-up and drop-off rates were increased to 2°/100 ft.

[10 Marks]

2. ABC field is located in offshore Sabah. On 30th September 2019, XYZ-1 well was drilled as vertical exploration cum development well to test the hydrocarbon potential in the field. Based on well report, the pore pressure and fracture pressure profile of XYZ-1 well are given in **APPENDIX-I**.

   a. Select the casing setting depths for different casings with the check for the likelihood of pipe sticking and kick-imposed pressure at surface casing shoe. Show the essential calculations to obtain the parameters.

   [15 Marks]

   b. Select the hole (bit) size, casing size and mud weight for the proposed section of the well.

   [10 Marks]

3. a. i. Differentiate between wellbore ballooning and wellbore kick.

[4 Marks]

ii. Explain the basic principle that guides all well kill methods.

[4 Marks]

b. A well experiencing a kick was shut in and the readings in **TABLE Q3** were recorded.

TABLE Q3: Shut in drillpipe and casing values

TIME	SIDPP	SICP
0700 hrs	250 psi	310 psi
0705 hrs	300 psi	370 psi
0710 hrs	350 psi	430 psi
0715 hrs	400 psi	500 psi
0720 hrs	410 psi	510 psi
0725 hrs	420 psi	520 psi
0730 hrs	430 psi	530 psi

Given that the mud weight = 12 ppg; the height of the influx = 400 ft; the well TVD = 8000 ft.

i. Estimate the influx density.

[6 Marks]

ii. Determine the type of kick fluid that made the well kick. Justify your answer.

[5 Marks]

iii. Recommend the kill mud weight that should be used to kill the well.

[5 Marks]

4. a. i. Explain the term – Equivalent Circulating Density (ECD) and highlight the factors that affects ECD.

[4 Marks]

ii. Differentiate between hard shut in and soft shut in.

[4 Marks]

b. The mud having properties shown in **TABLE Q4** is flowing through a 4.5 inches OD (ID = 3.64 inches), internal flush drill pipe of length 1000 ft. Estimate the frictional pressure drop if the mud is circulated at a rate of 400 gal/min.

TABLE Q4: Mud properties

Mud property	Value
Mud density, ρ_m	10 lb/gal
Bingham yield, Y_b	10 lb/100 ft^2
Plastic viscosity, μ_p	30 cP

[18 Marks]

- END OF PAPER -

APPENDIX-I

Pore pressure & Fracture gradients for XYZ-1 well.

TVD (ft)	Pore pressure (psi/ft)	Fracture pressure (psi/ft)
0	0.4654	0.5616
500	0.4654	0.5668
1000	0.4654	0.5824
1500	0.4654	0.5954
2000	0.4654	0.6084
2500	0.4654	0.6292
3000	0.4654	0.6500
3500	0.4654	0.6656
4000	0.4654	0.6864
4500	0.4654	0.7020
5000	0.4654	0.7124
5500	0.4654	0.7228
6000	0.4654	0.7332
6500	0.4654	0.7436
7000	0.4654	0.7540
7500	0.4836	0.7670
8000	0.5148	0.7800
8500	0.5460	0.7930
9000	0.5876	0.8060
9500	0.6240	0.8138
10000	0.6604	0.8216
10500	0.6812	0.8320
11000	0.6968	0.8398
11500	0.7124	0.8476
12000	0.7228	0.8554
12500	0.7332	0.8632
13000	0.7436	0.8684
13500	0.7514	0.8736
14000	0.7592	0.8772
14500	0.7644	0.8798
15000	0.7696	0.8814

$$V = \frac{q}{2.45d^2}$$

$$N_{Re} = \frac{2970\rho V d}{\mu_p}$$

$$V_c = \frac{1.08\mu_p + 1.08\sqrt{\mu_p^2 + 9.3\rho d^2 Y_b}}{\rho d}$$

$$\Delta P_p = \frac{\rho^{0.75} \times V^{1.75} \times L \times \mu_p^{0.25}}{1800 \times d^{1.25}}$$

$$Influx\ density = mud\ weight - \left(\frac{SICP - SIDPP}{0.052 * Influx\ height}\right)$$

$$Kill\ mud\ weight = Original\ mud\ weight + \frac{SIDPP}{0.052 * TVD}$$

Density	Kick fluid
1 – 3 ppg	Gas Kick
4 – 6 ppg	Oil kick or combination
7 – 9 ppg	Salt water kick