UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE	**:**	**PEB2034/PFB2054 - DRILLING ENGINEERING I**
DATE	**:**	**30 JULY 2024 (TUESDAY)**
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 **SIX (6)** pages in this Question Booklet including the cover page and the Appendix.

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

iii. Graph paper (s) will be provided.

1. a. A well is designed to be drilled to a depth of 16000 ft. The well is to be cased and cemented at certain predetermined depths. The pore pressure and fracture pressure data from offset wells drilled in the same formation is shown in **TABLE Q1**. Take the trip margin to be 1.5 ppg and kick margin to be 1.9 ppg.

TABLE Q1: Pore pressure data

Depth	Pore Pressure	Fracture pressure
0	8	12.4
2000	8.5	13.7
4000	9	14.2
6000	9.5	15
8000	10	17.3
10000	10.5	18
12000	13.5	18.7
14000	14.2	19.1
16000	14.8	19.6

Recommend the appropriate mud weight to be used for each well depth.

[16 marks]

b. Distinguish between overbalanced drilling and underbalanced drilling.

[4 marks]

c. Determine the amount of NaOH necessary to raise the pH of a water-based mud from 9.5 to 11.5. Take the molecular weight of NaOH to be 40 g/mol.

[4 marks]

2. a. After measuring the rheology of a drilling mud using a rotational viscometer, the data in **TABLE Q2** was obtained.

TABLE Q2: Pore pressure data

Shear rate (RPM)	Dial Reading
600	70
300	50
200	42
100	35
6	30
3	29

Use the information in **TABLE Q2** to determine the rheological parameters for the model that best describes the mud's behaviour.

[16 marks]

b. Explain in detail how mud viscosity is measured in the field. (Use diagrams where necessary).

[6 marks]

c. Define the terms – Dogleg and Fish.

[4 marks]

3. a. A deviated well with an angle of inclination of 30 degrees is drilled with a planned mud weight of 12.0 ppg. If the safety factor for this scenario is 25%. Determine the drill collar weight to obtain the desired weight on bit (WOB) of 50k lb.

[12 marks]

b. A rotational viscometer contains a fluid that gives a dial reading of twenty at a shear rate of 300 rpm and a dial reading of forty at a shear rate of 600 RPM. Prove that this fluid is a Newtonian fluid.

[6 marks]

c. Explain the procedure used to measure the gel strength of a mud. Highlight the differences between fragile gels and progressive gels.

[6 marks]

4. a. A drillstring is composed of 8,000 ft of 5-in. outer diameter and 4.276-in inner diameter, 19.5-lbm/ft drillpipe and 500 ft of 8-in. OD by $2\frac{3}{4}$-in ID drill collars when drilling a $9\frac{7}{8}$-in. borehole. Assuming that the borehole remains in gauge, compute the following:

i. The volume of mud in barrels that the drillstring can contain.

[6 marks]

ii. The capacity of the annular space between the drillstring and the hole (in bbl/ft)

[5 marks]

b. Drilling a well often comes with challenges most of which can be attributed to the drilling mud used. For each of the following challenges, highlight their causes and suggest one mud additive each that should be added to the mud system to control each of them.

i. Barite Sagging.

[5 marks]

ii. Drillpipe corrosion.

[5 marks]

iii. Wellbore Kick.

[5 marks]

END OF PAPER

APPENDIX I

$$P = 0.052 * \rho * TVD$$

$$Capacity\ (bbl) = \left(\frac{D^2 - d^2}{1029.4}\right) * Depth\ (ft)$$

$$\tau = \tau_y + \mu_p \gamma$$

$$\mu = \frac{\tau_{300}}{\gamma_{300}}$$

$$\frac{V_{f30} - V_{sp}}{V_{f1} - V_{sp}} = \frac{\sqrt{t_{30}}}{\sqrt{t_1}}$$

$$pH = -log_{10}[H^+]; \quad [H^+] = 10^{-pH}; \quad [H^+][OH^-] = 10^{-14}$$

$$PV = \theta_{600} - \theta_{300}; \quad YP = \theta_{300} - PV$$

$$\tau = k\gamma^n; \quad n = 3.32log\left(\frac{\theta_{600}}{\theta_{300}}\right) \quad ; \quad k = \frac{\tau_{300}}{\gamma_{300}^n}$$

$$BF = 1 - \frac{Mud\ Weight\ (MW)}{65.5}$$

$$Weight_{drill\ collar} = \frac{WOB * Safety\ Factor\ (SF)}{Buoyancy\ Factor\ (BF)}$$ [For Vertical wellbores]

$$Weight_{drill\ collar} = \frac{WOB * Safety\ Factor\ (SF)}{Buoyancy\ Factor\ (BF) * cos\theta}$$ [For Inclined wellbores]