UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE	:	**PEB3013 - PRODUCTION ENGINEERING II**
DATE	:	**7 AUGUST 2024 (WEDNESDAY)**
TIME	:	**2:30 PM - 5:30 PM (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 the Appendix.

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

iii. Graph paper (s) will be provided.

1. a. An International Oil Company (IOC) has got the right for acquisition of a field according to PSA system with the conditions stated **TABLE Q1a**:

TABLE Q1a

Royalty	12%
Tax	26%
Cost recovery limit	40%
Profit oil spilit (HG/IOC)	55%/45%

If the total revenue/barrel is $100, the respective operating and capital costs are $8/barrel and $7/barrel, calculate the divisions of Government/Contractor gross revenue, cash flow, and takes assuming a cummulative production of 300,000 barrels.

[10 marks]

b. Two-phase horizontal separator sizing calculation has resulted in the two expressions shown in **TABLE Q1b** for gas and liquid capacity constraints.

TABLE Q1b: Gas and Liquid Capacity Constraint Expressions

Gas capacity constraint	$L_{eff}d = 39.852$
Liquid capacity constraint	$L_{eff}d^2 = 8571.43$

i. Determine the optimum separator size based on the two expressions.

[12 marks]

ii. Explain the problems expected to occur if size smaller than the optimum size is selected.

[4 marks]

iii. Propose suitable internal components if the flow stream entring the seperator above is waxy and contain high amount of sand.

[4 marks]

2. a. The profitability of oil and gas business highly depends on the rights of aquisition that enables a contractor (i.e., international oil company) to develop and operate an oil field. Different contractual and concession models are available to govern the fiscal relationship between contractors and governments.

i. Explain the typical production profile of a petroleum filed and justify the profile trends at build-up, pleateu, and decline stages.

[4 marks]

ii. Explain how the government has more control in using the "Production License" agreement compared to the "Old Style Concession" agreement.

[4 marks]

iii. Differentiate between Production Sharing Contract (PSC) and Service Contracts.

[4 marks]

b. The settling velocity (V_t) of a two-phase separator can be calculated from:

$$V_t = 0.01186\left[\left(\frac{\rho_o - \rho_g}{\rho_g}\right)\right]\left(\frac{d_m}{C_D}\right)^{1/2}$$

where, ρ_o = density of oil, lb/ft^3, ρ_g = density of gas, lb/ft^3, d_m = oil droplet diameter, μm, C_D = drag coefficient, dimensionless

Reynolds Number (N_{Re}) is defined as:

$$N_{\mathrm{Re}} = 0.0049\frac{\rho_g d_m V_t}{\mu_g}$$

where, μ_g = viscosity of gas, cp

Use the data given in **TABLE Q2**:

Calculate the terminal velocity assuming laminar (Stokes) flow. Then, calculate the terminal velocity after two iterations using the procedure in the **APPENDIX**.

[8 marks]

TABLE Q2: Two-Phase Separator Sizing Data

Gas density (lb/ft^3)	3.71
Oil density (lb/ft^3)	51.1
Operating pressure (psia)	1250
Operating temperature (^oF)	62
Gas compressibility factor	0.84
Viscosity of gas (cp)	0.013
Droplet size (micron)	150
Reynolds number	96.91

3. a. Level control inside 3-phase separator is a challenging task. Two methods are used for oil-water interface level control. Discuss and evaluate **ONE (1)** of these methods.

[7 marks]

b. Types of mist extractor depend on the processed fluid. Evaluate the **THREE (3)** types of mist extractor.

[15 marks]

c. Treaters are used to treat separated oils that exit the initial separation performed by separators. Describe vertical treater and explain how it performs oil treatment.

[8 marks]

4. a. The separation is performed inside the separators in four different sections, namely inlet divertor, mist extractor, gravity settling section, and liquid collection section. Describe how liquid and gas are separated from each other after the flow stream passes the inlet divertor.

[6 marks]

b. Describe the method of **THREE (3)** special purpose separators on processing high-gas-liquid ratio fluids.

[6 marks]

c. Emulsions in petroleum production are tight mixtures of oil and water that cannot be separated by gravity difference. Answer the following questions:

i. Explain **THREE (3)** fluid properties that affect emulsion stability.

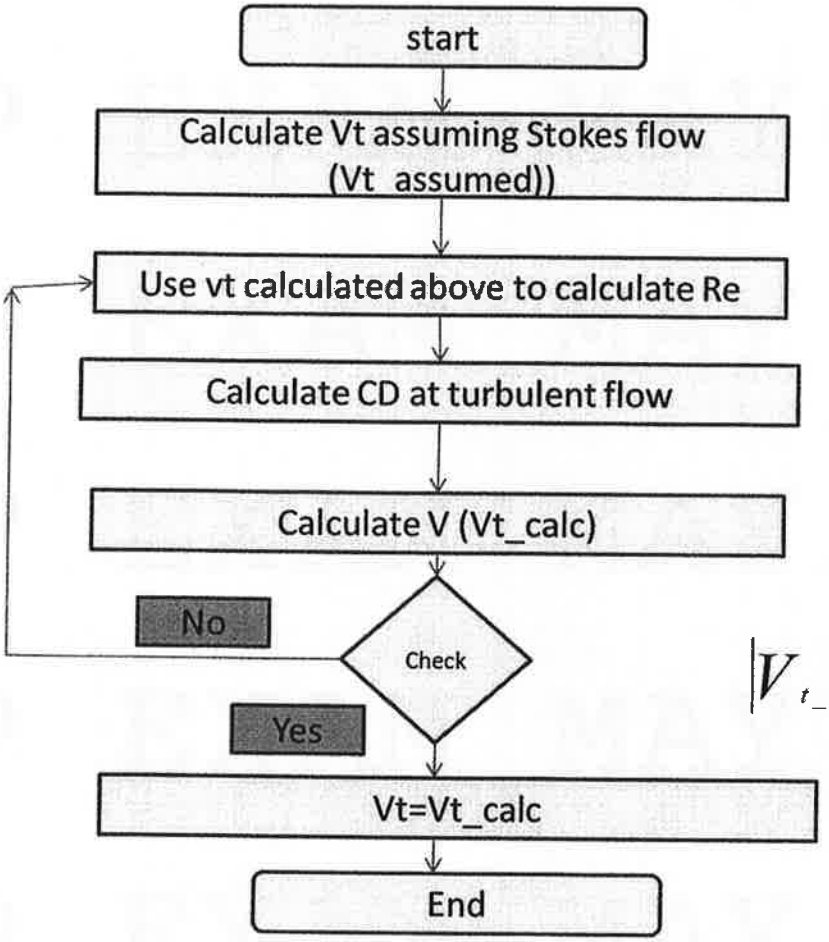
[6 marks]

ii. State **TWO (2)** methods used for emulsion treatment.

[2 marks]

END OF PAPER

APPENDIX



$$V_t = 0.0204\left[\frac{(\rho_l-\rho_g)d_m}{\rho_g}\right]^{0.5}$$

$$\mathrm{Re} = 0.0049\frac{\rho_g V_t d_m}{\mu_g}$$

$$C_D = \frac{24}{\mathrm{Re}} + \frac{3}{\mathrm{Re}^{0.5}} + 0.34$$

$$V_t = 0.0119\left[\frac{(\rho_l-\rho_g)}{\rho_g}\frac{d_m}{C_D}\right]^{0.5}$$

$$\left|V_{t\_assumed} - V_{t\_calc}\right| \le e$$