UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	DESIGN OF WASTEWATER ENGINEERING
COURSE CODE	:	BFA 40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 The grit chamber plays an important role in protecting the downstream equipment of a wastewater treatment plant from damage and wear caused by abrasive grit particles.

(a) Explain the mechanism of grit separation from wastewater in a grit chamber.

(3 marks)

(b) Illustrate an aerated grit chamber (with labels).

(4 marks)

(c) Recommend **TWO (2)** technical solutions to an incident where the overdue grit cleaning past the recommended maximum detention time.

(6 marks)

(d) Design a horizontal flow grit chamber comprising two channels for a sewage treatment facility to accommodate a maximum daily sewage flow of 58,000 m^3/day that comply with the following:

(i) Maximum settling velocity: 0.2 m/s,
(ii) Flow-through velocity: 0.1 m/s
(iii) Depth-to-width ratio: 1:2
(iv) Length-to-width ratio: 2:1
(v) Detention time: 3 to 5 minutes.

(12 marks)

Q2 Primary sedimentation tanks are typically designed to remove 30 to 60% of the total suspended solids from the wastewater. However, the removal efficiency will vary depending on the wastewater characteristics and the design and operation of the tank.

(a) Demonstrate **THREE (3)** possible condition that lead to the inefficiency of primary sedimentation in removing setteable solids.

(3 marks)

(b) Outline **TWO (2)** operation and maintenance works need to be done to allow the primary sedimentation tank meet it purposes.

(4 marks)

(c) Justify **TWO (2)** importance of determining the scour velocity of primary sludge prior to the design of the primary settling tank.

(6 marks)

(d) Design a rectangular primary sedimentation tank for treating sewage from a population equivalent of 357,600 with surface loading rate of 45 $m^3/m^2/day$ using the following:

(i) Sewage generation : 88% of the water consumpation
(ii) (225 to 275 litres per capita per day)
(iii) Number of primary sedimentation tank unit: 2
(iv) Length-to-width : > 3:1
(v) Detention time : 2 hours.

(12 marks)

Q3 Biological treatment is essential in wastewater treatment plant for removing organic matter, nutrients, and other pollutants from wastewater to comply with the effluent discharge standard before flows into rivers or lakes.

(a) Sketch the flow and treatment process of wastewater into the activated sludge reactor until it reaches the secondary clarifier.

(3 marks)

(b) Distinguish between rotating biological contactors and trickling filters typically used as biological treatment options.

(4 marks)

(c) Recommend **TWO (2)** secondary treatment systems capable of complementing primary treatment and elucidate how they overcome the limitations of primary treatment.

(6 marks)

(d) Permai Eco Residence has to upgrade its primary wastewater treatment facility to a biological treatment plant in which a completely mixed-activated sludge system has been selected . Primary wastewater treatment facility was designed using wastewater flowrate of 0.155 m^3/s and BOD_5, S_0 of 80.0 mg/L. Design the aeration tank by calculating the mean cell residence time and the volume of the aeration tank, V, for the MLVSS ranges between 2000 to 3000 mg/L.

Assuming the following values:

(i) Allowable soluble BOD_5, $S = 12$ mg/L
(ii) $K_s = 85.0$ mg/L BOD_5
(iii) $Y = 0.60$ mg VSS/ mg BOD_5 removed
(iv) $\mu_m = 3$/day
(v) $k_d = 0.04$/day

(12 marks)

Q4 In Malaysia, wastewater treatment plants produce approximately 3.2 million cubic meters of sludge each year. This sludge contains high levels of organic matter, nutrients, and pathogens, making it difficult and expensive to dispose of in a safe and environmentally friendly manner.

(a) Sketch the flow of sludge treatment processes.

(3 marks)

(b) Point out **TWO (2)** key challenges in managing wastewater treatment plant sludge in a sustainable way.

(4 marks)

(c) Differentiate between primary and secondary sludge in terms of source, composition and density.

(6 marks)

(d) As a senior engineer, you are proposing the generation of renewable energy from sludge. Produce the presentation material that should encompass the specific impacts of untreated sludge according to Malaysian standards, the sludge treatment processes, and strategies for generating renewable energy from sludge.

(12 marks)

- END OF QUESTIONS -

APPENDIX : FORMULAE

$$A_s = \frac{Q_{peak}}{SLR} \qquad A_s = \frac{Q_{peak}}{v_h} \qquad Q_{peak} = Q_{avg} \times PFF \qquad Q_{peak} = Q_{avg} \times PF$$

$$PF = 4.7 \times p^{-0.11} \qquad Q_{avg} = PE \times Q_{design} \qquad Volume = Q \times t$$

$$S = \frac{K_s(1 + k_d\theta_c)}{\theta_c(\mu_m - k_d) - 1} \qquad X = \frac{\theta_c Y(S_0 - S)}{\theta(1 + k_d\theta_c)} \qquad \theta = \frac{V}{Q}$$

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