Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	ENVIRONMENTAL ENGINEERING
COURSE CODE	:	DAC 12203
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Answer ALL Questions

Q1 **Figure Q1** shows the river water flow from upstream to downstream (Sea). The result of water quality for Section A, B, C, and D as **Table Q1(a)**. By referring to Table Q1(b) – Q1(d): Calculate,

(a) Calculate the Water Quality Index (WQI) for Section B.

(14 marks)

(b) Classify the quality of River in Section B by referring the DOE Water Quality Index Classification.

(2 marks)

(c) Classify the beneficial uses of River in Section B from the result.

(2 marks)

(d) Summarize the quality status index range from upstream to downstream if the WQI analysis at section A, C and D are Class IV.

(2 marks)

Q2 (a) The river has the ability to decompose organic wastes that enter the stream naturally. This self-purification capacity of river water is an essential indicator of a healthy river as shown in **Figure Q2(a).** Identify lines represented by **X, Y** and **Z**. Explain T**wo (2)** factors contributing to changes in the concentration of Dissolved Oxygen (DO) of line **X**.

(10 marks)

(b) When wastewater is discharged into a stream, the data of water parameters at the mixing point is shown in **Table Q2(b)**. Given the deoxygenation coefficient, kd= 0.25/day, and reaeration coefficient kr= 0.42/day. Calculate

i. Initial oxygen deficit.

(2 marks)

ii. Ultimate BOD based 5 days data.

(2 marks)

iii. Critical oxygen deficit time

(2 marks)

iv. Critical oxygen deficit value

(2 marks)

v. Critical oxygen deficit location in km

(2 marks)

Q3 (a) Surface water and underground water are the sources of domestic water supply. Compare **Three (3)** characteristics of surface water and underground water.

(6 marks)

(b) Name **Two (2)** cations that cause water hardness that can be removed easily by using an ion exchange procedure.

(4 marks)

(c) A primary circular settling tank in a water treatment plant has an average flow of 6000 m^3/day, a surface area of the tank is 200 m^2 and a peak factor of 1.2, calculate the Surface Overflow Rate (SOR) at peak flow

(2 marks)

(d) Water distribution systems aim to preserve the quality and quantity of water, as well as maintain sufficient pressure in the distribution of water. Name and sketch the following water distribution layout.

(i) Water distribution layout with distribution reservoir.

(4 marks)

(ii) Water distribution layout suitable for old towns having no different pattern of roads.

(4 marks)

Q4 (a) State **Two (2)** classifications of wastewaters.

(2 marks)

(b) Give **Three (3)** examples of wastewater sources for heavy graywater.

(3 marks)

(c) Calculate the volume of primary circular settling tank if the average flow is 6500 m^3/day with a peak factor of 3.0 and Surface Overflow Rate (SOR) of 35 m^3/day/m^2 is required. Assume the side wall depth is 2.5 m.

(3 marks)

(d) Calculate the detention time for primary tank design with the following data given in **Table Q4(d)**.

(4 marks)

(e) A primary circular clarifier needs to remove 60 % of the suspended solid (SS) if the average flow is 5500 m^3/day with a peak factor of 3.0. In order to achieve 60% SS reduction and 40% BOD reduction, a Surface Overflow Rate (SOR) of 50 m^3/day/m^2 is required. Assume the side wall depth is 4.5 m. Determine the surface area required, diameter, volume, detention time and SOR at peak flows.

(8 marks)

Q5 (a) List **Four (4)** impacts from the disposal of municipal solid waste.

(4 marks)

(b) There are many terms related to solid waste. Give **Two (2)** comparisons between "garbage" and "rubbish".

(4 marks)

(c) Calculate the moisture content of 130kg of solid waste samples with the following composition in **Table Q5(a)** Refer to **Table Q5(b)** for a typical density and moisture content value.

(6 marks)

(d) Calculate the waste generated per year if a population of 150000 generating 35 kg per household per week. Assume 3.5 persons per household. Then determine the required area for a new landfill site with a projected life of 20 years, assuming the density of waste is 500 kg/m3. The height of the landfill is limited to 10 m.

(6 marks)

-END OF QUESTIONS –

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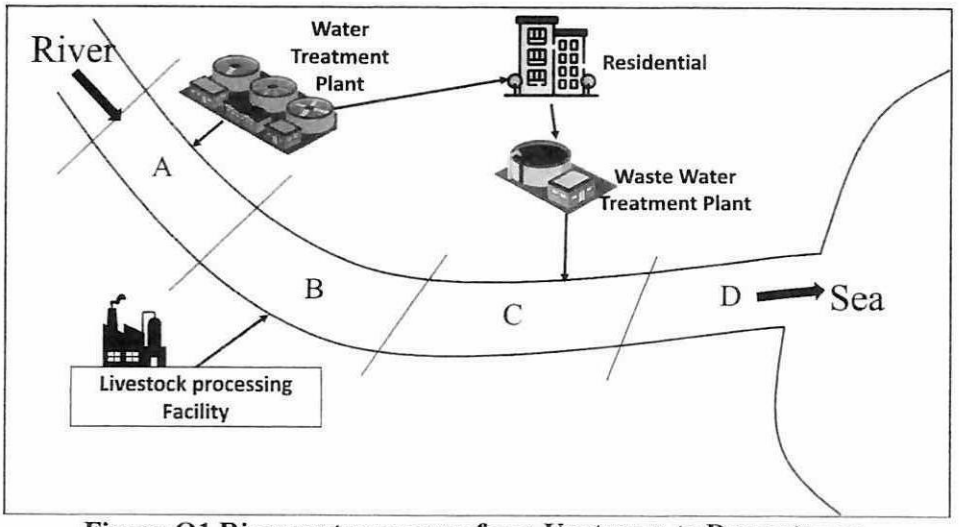

Figure Q1 River water sources from Upstream to Downstream

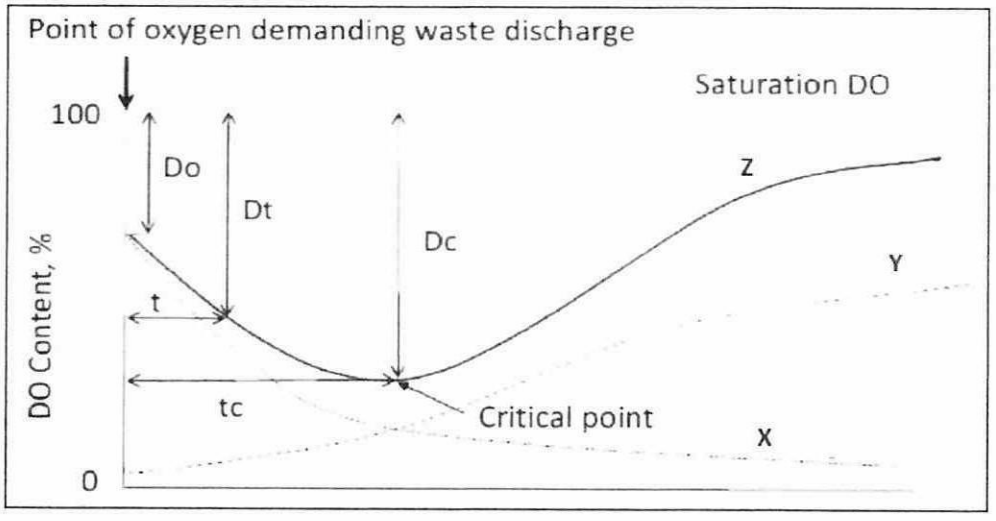

Figure Q2(a) Oxygen Sag Curve

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LIST OF FORMULA AND TABLES :

WQI = (0.22*SIDO) +(0.19*SIBOD) +(0.16*SICOD) +(0.15*SIAN) +(0.16*SISS) + (0.12*SipH)

where;

SIDO = SubIndex DO (% saturation)

SIBOD = SubIndex BOD

SICOD = SubIndex COD

SIAN = SubIndex NH_3–N

SISS = SubIndex SS

SipH = SubIndex pH

$0 \leq WQI \leq 100$

SubIndex for DO (In % saturation)	
SIDO = 0 SIDO = 100 SIDO = $-0.395 + 0.030x^2 - 0.00020x^3$	for $x \leq 8$ for $x \geq 92$ for $8 < x < 92$
SubIndex for BOD	
SIBOD = $100.4 - 4.23x$ SIBOD = $108^* \exp(-0.055x) - 0.1x$	for $x \leq 5$ for $x > 5$
SubIndex for COD	
SICOD = $-1.33x + 99.1$ SICOD = $103^* \exp(-0.0157x) - 0.04x$	for $x \leq 20$ for $x > 20$
SubIndex for NH_3–N	
SIAN = $100.5 - 105x$ SIAN = $94^* \exp(-0.573x) - 5^* \lvert x - 2 \rvert$ SIAN = 0	for $x \leq 0.3$ for $0.3 < x < 4$ for $x \geq 4$
SubIndex for SS	
SISS = $97.5^* \exp(-0.00676x) + 0.05x$ SISS = $71^* \exp(-0.0061x) + 0.015x$ SISS = 0	for $x \leq 100$ for $100 < x < 1000$ for $x \geq 1000$
SubIndex for pH	
SIpH = $17.02 - 17.2x + 5.02x^2$ SIpH = $-242 + 95.5x - 6.67x^2$ SIpH = $-181 + 82.4x - 6.05x^2$ SIpH = $536 - 77.0x + 2.76x^2$	for $x < 5.5$ for $5.5 \leq x < 7$ for $7 \leq x < 8.75$ for $x \geq 8.75$
Note: *means multiply	

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$$L_o = \frac{Y_m}{1 - e^{-kt}}$$

$$t_c = \frac{1}{k_r - k_d} In \left[\frac{k_r}{k_d}\left(1 - D_o \frac{k_r - k_d}{k_d L_o}\right)\right]$$

$$D_c = \frac{k_d}{k_r} L_o e^{-k_d t_c}$$

$$x = ut_c$$

$$\text{Surface over flow rate (SOR)} = \frac{peak\ flow\ x\ flowrate}{\text{area}}$$

Detention time = Volume, V / Flow rate, Q

$$\text{Moisture Content} = \frac{(\text{w} - \text{d})100}{\text{w}}$$

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Table Q1(a) The data of water quality measurement for river flow from section A to section D

Parameters	Section A	Section B	Section C	Section D
Dissolved Oxygen (% saturation)	47.22	58.98	51.25	45.21
Biochemical Oxygen Demand, BOD (mg/L)	5.67	20.77	18.76	11.25
Chemical Oxygen Demand, COD (mg/L)	78	150	121	96
Ammoniacal Nitrogen (mg/L NH_3-N)	2.21	3.45	3.01	2.54
Suspended Solid (mg/L)	150	259	199	178
pH	9.25	8.59	7.29	7.15

Table Q1(b) DOE Water Quality Index Classification

Parameter	Unit	Class				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/L	<0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
Biochemical Oxygen Demand	mg/L	<1	1-3	3-6	6-12	>12
Chemical Oxygen Demand	mg/L	<10	10-25	25-50	50-100	>100
Dissolved Oxygen	mg/L	>7	5-7	3-5	1-3	<1
pH	-	>7	6-7	5-6	<5	>5
Total Suspended Solid	mg/L	<25	25-50	50-150	150-300	>300
Water Quality Index (WQI)	-	<92.7	76.5-92.7	51.9-76.5	31.0-51.9	>31.0

Table Q1(c) Water Classes and Uses

Class	Uses
Class I	Conservation of natural environment. Water Supply I - Practically no treatment necessary. Fishery I - Very sensitive aquatic species.
Class IIA	Water Supply II - Conventional treatment. Fishery II - Sensitive aquatic species.
Class IIB	Recreational use body contact.
Class III	Water Supply III - Extensive treatment required. Fishery III – Common of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above

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Table Q1(d) DOE Water Quality Classification Based on Water Quality Index

Sub Index & Water Quality Index	Index Range		
	Clean	Slightly Polluted	Polluted
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH_3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

Table Q2(b) Concentration of DO and BOD at Mixing Point.

Parameter	Concentration
Biological Oxygen Demand (BOD_m)	50.4 $^{mg}/_{L}$
Dissolved Oxygen (DO_m)	5.2 $^{mg}/_{L}$
Temperature (T_m)	27.0 °C
Mixing velocity, (u)	0.15 m/s

Table Q2 (b) (i) Oxygen Saturation Value, C_o at Different Temperature.

Temperature (°C)	Oxygen Saturation Value, C_o($^{mg}/_{L}$)
25.0	8.3
25.5	8.2
26.0	8.1
26.5	8.0
27.0	8.0
27.5	7.9
28.0	7.8

Table Q4(d) Design data

Flow	0.150 m^3/s
Length	50.0 m (effective)
Width	15.0 m
Liquid depth	2.5 m
Weir length	65.0 m

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Table Q5(a) Composition of Solid Waste

Component	Mass (kg)
Food waste	65
Paper	38
Textile	16
Plastics	11

Table Q5 (b): Density and Moisture Content

Component of Waste	Typical Density (kg/m^3)	Moisture Content (% of weight)
Food	290	70
Paper and cardboard	70	5
Plastics	60	2
Glass	200	2
Metal	200	2
Clothing/textiles	60	10
Ashes/dust	500	8
Wood	240 100 300 500 600	20 20 20 25 25