



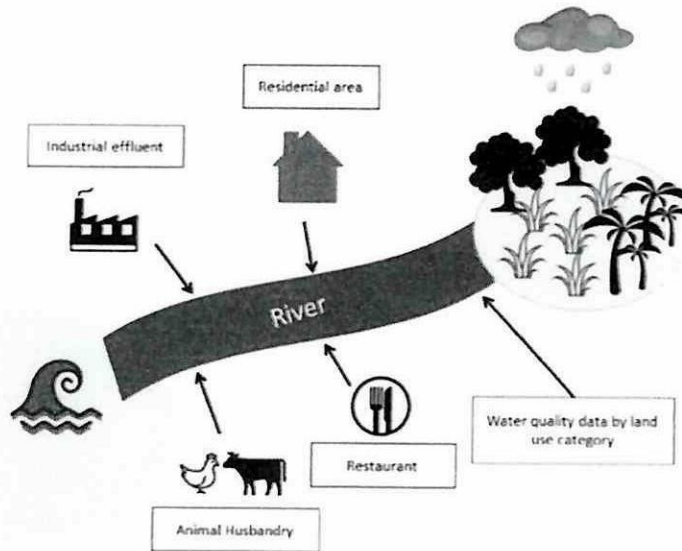
UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION  
SEMESTER II  
SESSION 2023/2024

- COURSE NAME : ENVIRONMENTAL ENGINEERING
- COURSE CODE : DAC 12203
- PROGRAMME CODE : DAA
- EXAMINATION DATE : JULY 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 CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 **Figure Q1.1** shows the river of Sungai Kempas. There are a lot of activities and industries surrounding the river that can affect the water quality.



**Figure Q1.1**

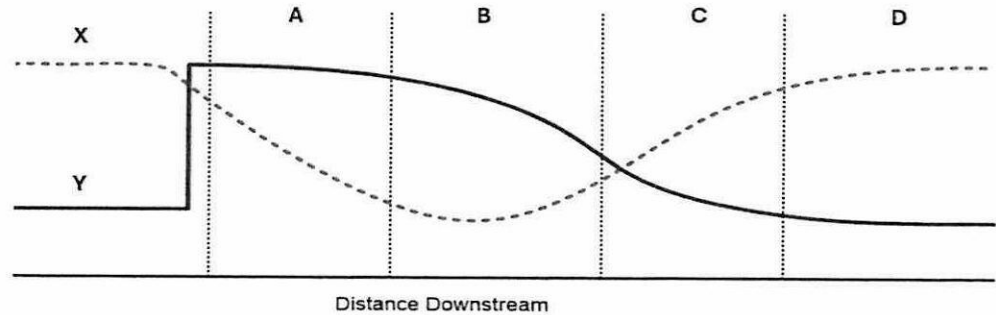
- (a) List two (2) parameters for each physical and chemical parameter used to assess water quality as presented in **Figure Q1.1**.  
(2 marks)
- (b) **Table APPENDIX A.2** shows the data on water quality measurement for Sungai Kempas. Given that the subindexes for pH and COD are 27.15 and 59.90, respectively (Refer to **Table APPENDIX A.1** for other subindexes). Calculate the water quality index (WQI) for that river.  
(10 marks)
- (c) By referring to **Table APPENDIX A.3 to APPENDIX A.5**, classify the water quality classes and the status of the index range for Sungai Kempas.  
(2 marks)
- (d) A water sample having a pH of 8.0 and containing 70 mg/L  $\text{Ca}^{2+}$ , 30 mg/L  $\text{Mg}^{2+}$  and 15 mg/L  $\text{Na}^+$  ions. Determine the hardness in mg/L as  $\text{CaCO}_3$ . Given the atomic weights of  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and  $\text{Na}^+$  as 40, 24.3, and 22.9.  
(6 marks)

**Q2** (a) Define the oxygen sag curve of a river

(2 marks)

(b) **Figure Q2.1** shows the self-purification process of a river when wastewater enters the stream. Identify the line labeled X and Y. Name the A, B, C, and D zones.

(6 marks)



**Figure Q2.1**

(c) Explain two (2) factors that affect the dissolved oxygen concentration in water.

(4 marks)

(d) An industrial wastewater enters a stream. Data on the mixing point of sewage entering a stream is shown in **Table Q2.1**. Based on the given data, determine:

**Table Q2.1**

Items	Value
Sewage discharge	8 m <sup>3</sup> /s
Combined Waste discharge	20 m <sup>3</sup> /s
River water BOD <sub>5</sub>	6.8 mg/L
Wastewater BOD <sub>5</sub>	40 mg/L
Deoxygenation constant	0.26/day
After mixing velocity	0.28 m/s
Critical deficit time	4 days

(i) River flow,  $Q_r$  (m<sup>3</sup>/s).

(2 marks)

(ii) BOD after mixing, BOD<sub>m</sub> (mg/L).

(2 marks)

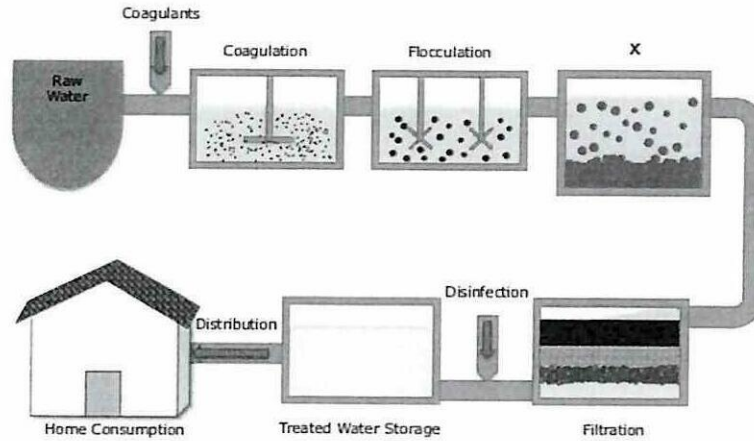
(iii) Ultimate BOD<sub>5</sub>,  $L_0$  (mg/L)

(2 marks)

(iv) Location of critical deficit,  $x$  (km)

(2 marks)

- Q3** (a) Sources of water for domestic water supply treatment plants are most often either surface water or groundwater. Define two (2) characteristics of surface water and groundwater. (4 marks)
- (b) **Figure Q3.1** shows the processes in a water treatment plant. Identify and explain the water treatment process label by **X**.



**Figure Q3.1**

- (c) The design flow for two sedimentation tanks is  $0.04 \text{ m}^3/\text{s}$ . Given the design overflow rate for the tanks is  $18 \text{ m/day}$ . (6 marks)
- (i) Determine the surface area of the sedimentation tanks. (2 marks)
- (ii) Calculate the depth of the sedimentation for the detention time of 120 minutes. (4 marks)
- (d) Sketch the following types of water supply distribution systems. (2 marks)
- (i) Grid Iron System (2 marks)
- (ii) Radial System (2 marks)

Q4 (a) List three (3) examples of wastewater sources for heavy graywater.

(3 marks)

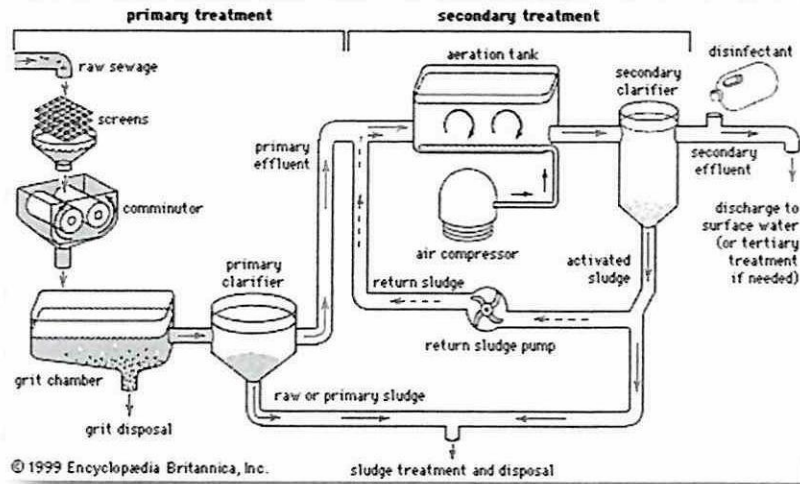


Figure Q4.1

(b) Figure Q4.1 shows a common flow chart of the wastewater treatment process divided into several stages which are preliminary, primary, and secondary. Briefly discuss the following process.

(i) Screening

(3 marks)

(ii) Coagulation and Flocculation

(3 marks)

(iii) Sedimentation

(3 marks)

(c) A primary circular clarifier must remove 70 % of the suspended solid (SS) if the average flow is 6000 m<sup>3</sup>/day with a peak factor 3.5. To achieve 70% SS reduction and 30% BOD reduction, a Surface Overflow Rate (SOR) of 40 m<sup>3</sup>/day/m<sup>2</sup> is required. Assume the side wall depth is 4.5 m. Determine:

(i) Surface area required

(2 marks)

(ii) Diameter and volume

(2 marks)

(iii) Detention time and SOR at peak flows.

(4 marks)

**Q5** Solid waste management is a term that is used to refer to the process of collecting and treating solid wastes.

(a) Describe two (2) objectives of municipal solid waste (MSW) management. (4 marks)

(b) List four (4) types of residential solid waste collection services. (4 marks)

(c) Calculate the area required for a new landfill site with a projected life of 30 years for a population of 300,000 generating 25 kg per household per week. Assume the density of waste is  $600 \text{ kg/m}^3$ . A planning restriction limits the height of the landfill to 12 m. Assume 4 persons per household. (6 marks)

(d) Discuss the advantages and disadvantages of landfills to dispose of solid waste. (6 marks)

- END OF QUESTIONS -

**APPENDIX AND LIST OF FORMULA**

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

$$0 \leq WQI \leq 100$$

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

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

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

$$x = ut_c$$

**Table APPENDIX A.1 Sub-Index for WQI**

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

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**Table APPENDIX A.2 Data for water quality**

Parameters	Data
Dissolve Oxygen (% saturation)	47.22
Biochemical Oxygen Demand, BOD (mg/L)	5.67
Ammoniacal Nitrogen, (mg/L NH <sub>3</sub> -N)	2.21
Suspended Solid (mg/L)	150

**Table APPENDIX A.3 Water Quality Index Classification by DOE**

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

**Table APPENDIX A.4 Water classes and uses**

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

**Table APPENDIX A.5 Water Quality Index Range by DOE**

Sub Index & Water Quality Index	Index Range		
	Clean	Slightly Polluted	Polluted
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH <sub>3</sub> -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

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