First Semester Examination
2021/2022 Academic Session

February/March 2022

EAP315 – Wastewater Engineering

Duration : 2 hours

Please check that this examination paper consists of **TEN (10)** pages of printed material, including the appendix, before you begin the examination.

Instructions : This paper contains **FOUR (4)** questions. Answer **QUESTION 1** in **PART A** (**COMPULSORY)** and **ANY OTHER TWO (2) QUESTIONS** in **PART B.**

All questions **MUST BE** answered on a new page.

PART A : COMPULSORY

1. (a). Differentiate with appropriate sketches the difference between primary and secondary wastewater treatment processes.

[6 marks]

(b). A primary sedimentation tank in an activated sludge process receives a design flow of 1,000 m^3/day. If the length to width ratio of the tank is kept at 3:1 and its Surface Overflow Rate (SOR) is 25 m^3/m^2.day, calculate the width and length of this tank.

[6 marks]

(c). There are many important parameters involved in the design of a secondary sedimentation tank. With the help of a sketch and with an appropriate unit, write the relation between the volume and the flow factoring into the tank, retention time, surface overflow rate and weir loading rate.

[6 marks]

(d). Calculate the size of an extended aeration tank to treat a wastewater from a population with the following data:

BOD load	37.7 ton/day
MLVSS	2000 mg/L
F:M ratio	0.30 kg BOD/kg MLVSS.day

[7 marks]

(e). i) Given the concentration of BOD_5 of wastewater is 200 mg/L and the water usage is 200 L/capita.day. Determine the BOD_5 loading for this wastewater.

[5 marks]

ii) A wastewater treatment engineer proposes a split system for a sewer system. Explain and justify whether it is a good system.

[5 marks]

(f). A sample of sewage is diluted by a factor of 6:100 using seeded dilution water. The initial DO of the diluted sample was 7.00 mg/L and the final DO after 5 days was 3.00 mg/L. The corresponding initial and final DO of the seeded dilution water was 7.20 mg/L and 6.55 mg/L, respectively. Calculate the BOD_5 of the sewage sample.

[5 marks]

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PART B : ANSWER 2 OUT OF 3 QUESTIONS

2. (a). Describe the importance to reduce the amount of biodegradable organic matter and nutrients in sewage treatment.

[10 marks]

(b). A newly developed housing area consists of 10000 PE. A sewer system needs to be installed in that area with a 0.023 m/m slope. With a proper justification and Manning roughness coefficient, n as 0.013, design the sewer system.

[20 marks]

3. (a). The formation of undesirable volatile fatty acids and alcohol during the anaerobic process remains as a hindrance in harvesting and utilization of useful biogas like methane. With the help of an anaerobic process diagram, explain THREE (3) factors that create an imbalance in volatile fatty acid concentration and methane production.

[15 marks]

(b). Operating variables such as pH, dissolved oxygen, temperature, aeration, reaction and retention time are controlled and regularly monitored at the sewage treatment plant with the aim of achieving optimum performance for organic matter removal. Select **THREE (3)** operating conditions based on the above statement and determine the effect of each selection on the rate of microbial growth at a secondary treatment unit that uses an aerobic process.

[15 marks]

4. (a). Discuss the importance of controlling the wastewater velocity at the screen's face and explain how it is done.

[6 marks]

(b). A wastewater is mechanically screened at the treatment plant at Q_{peak}. The screen opening is 20 mm. If the maximum effective surface area of the screenings tank for 8 days storage is 2 m^2 and the effective depth of the tank is 3 m, using **Figure 1**, determine the contributed flow in m^3/day that produces the screenings.

[10 marks]

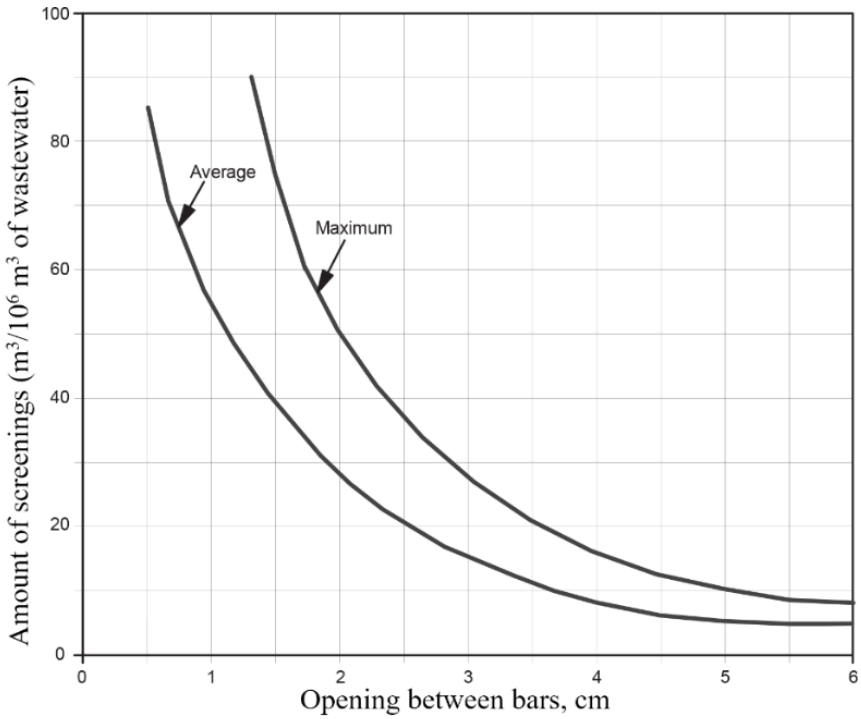

FIGURE 1 Screenings chart (MSIG, Volume 4, 2009)

(c). An effluent from sedimentation tank is biologically treated by RBC with design data as follows:

- Number of series = 4
- Number of disk/series =30
- Daily BOD load =10 kg
- Total Organic Load = 9.7 g/m^2.day

Determine the diameter of the media disc of this plant.

[8 marks]

(d). A cylindrical low rate trickling filter is operating at the following design conditions:

- Organic Loading=0.10 kg BOD_5/m^3.day
- Gross volume of media=1000 m^3
- Media ratio=55%
- Water consumption rate=225 Liter/capita.day

Calculate the BOD load of this plant.

[6 marks]

APPENDICES

Peak faktor = $4.7\ p^{-0.11}$ (p in thousand)

Retention time=Volume/discharge

Population Equivalent = $\frac{\text{Organic load from premises}}{\text{Organic load from 1 person}}$

Manning: $Q=(1/n)\ (A)\ (R)^{2/3}\ (s)^{1/2}$

$V=(1/n)\ (R)^{2/3}\ (s)^{1/2}$

$R=A/P$

Width of screen = $\frac{\text{(width of blade + opening)}}{\text{(opening)}}\ \frac{\text{(Discharge)}}{\text{(velocity) (depth of wastewater)}}$

Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{\text{(Pumping rate-Dry Weather Flow)}}$

Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$

Solids Loading Rate = $\frac{\text{(Discharge) (Mixed Liquor)}}{\text{Surface Area}}$

Weir Loading Rate = $\frac{\text{Discharge}}{\text{Length of weir}}$

Volume of pyramid = (1/3) (base area) (height)

Organic Load = (Discharge) (BOD)

BOD kinetic $BOD_t=Lo(1-10^{-k1t})$

$k_T=k_{20}(1.047)^{(T-20)}$

$L_T=L_{20}[1+0.02(T-20)]$

Thomas: $(t/BOD)^{1/3} = (kL_o)^{-1/3} + (k^{2/3}/6L_o^{1/3})\ t$

Volumetric Organic Loading = $\frac{\text{(Discharge) (BOD)}}{\text{Volume}}$

Food: Microorganism = $\frac{\text{(Discharge) (BOD)}}{\text{(Volume) (Mixed liquor)}}$

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Aerial organic loading = $\frac{\text{(Discharge) (BOD)}}{\text{Surface area}}$

Oxygen requirement = $\frac{Q \times BOD_5}{BOD_5/BOD_L}$ - 1.42 Px

Sludge yield = $\frac{y}{1+kd\theta c}$ (Discharge)(BOD)

Return sludge ratio $R=\frac{\text{Return sludge discharge}}{\text{Discharge}}$

$$X_a=X_R(R/1+R)$$

Sludge age = $\frac{\text{(Volume) (Mixed liquor)}}{\text{(Wasted discharge)(Underflow concentration)}}$

$$1/\theta=yu-k_d$$

Sludge volume index (SVI) = (MLSS settled in 30 minutes)/MLSS

Septic tank, C=225P

Pond design:

$L_e/L_i = 1/(1+k_1t)$

$A = Q/Dk_1 [L_i/L_e-1]$

$k_T = 0.30 (1.085)^{T-20}$

Organic Loading = L_iQ/A

Maximum Organic Loading = $7.5 (1.054)^T$

Recommended Population Equivalent (Source: Malaysian Standard 1228)

Type of Premises/Establishment	**Recommended Population Equivalent (PE)**
Residential	5 per house
Commercial: Includes offices, shopping complex, entertainment/recreational centres, restaurants, cafeteria, theatres	3 per 100 m^2 gross area
Schools/Educational Institutions: - Day schools/Institutions - Fully residential - Partial residential	 0.2 per student 1 per student 0.2 per non-residential student 1 per residential student
Hospitals	4 per bed
Hotels with dining and laundry facilities	4 per room
Factories, excluding process water	0.3 per staff
Market (wet type)	3 per stall
Market (dry type)	1 per stall
Petrol kiosks/Service stations	15 per toilet
Bus terminal	4 per bus bay
Taxi terminal	4 per taxi bay
Mosque/Church/Temple	0.2 per person
Stadium	0.2 per person
Swimming pool/Sports complex	0.5 per person
Public toilet	15 per toilet
Airport	0.2 per passenger 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf course	20 per hole

The water consumption rate, (q) is 225 Liter/capita.day.

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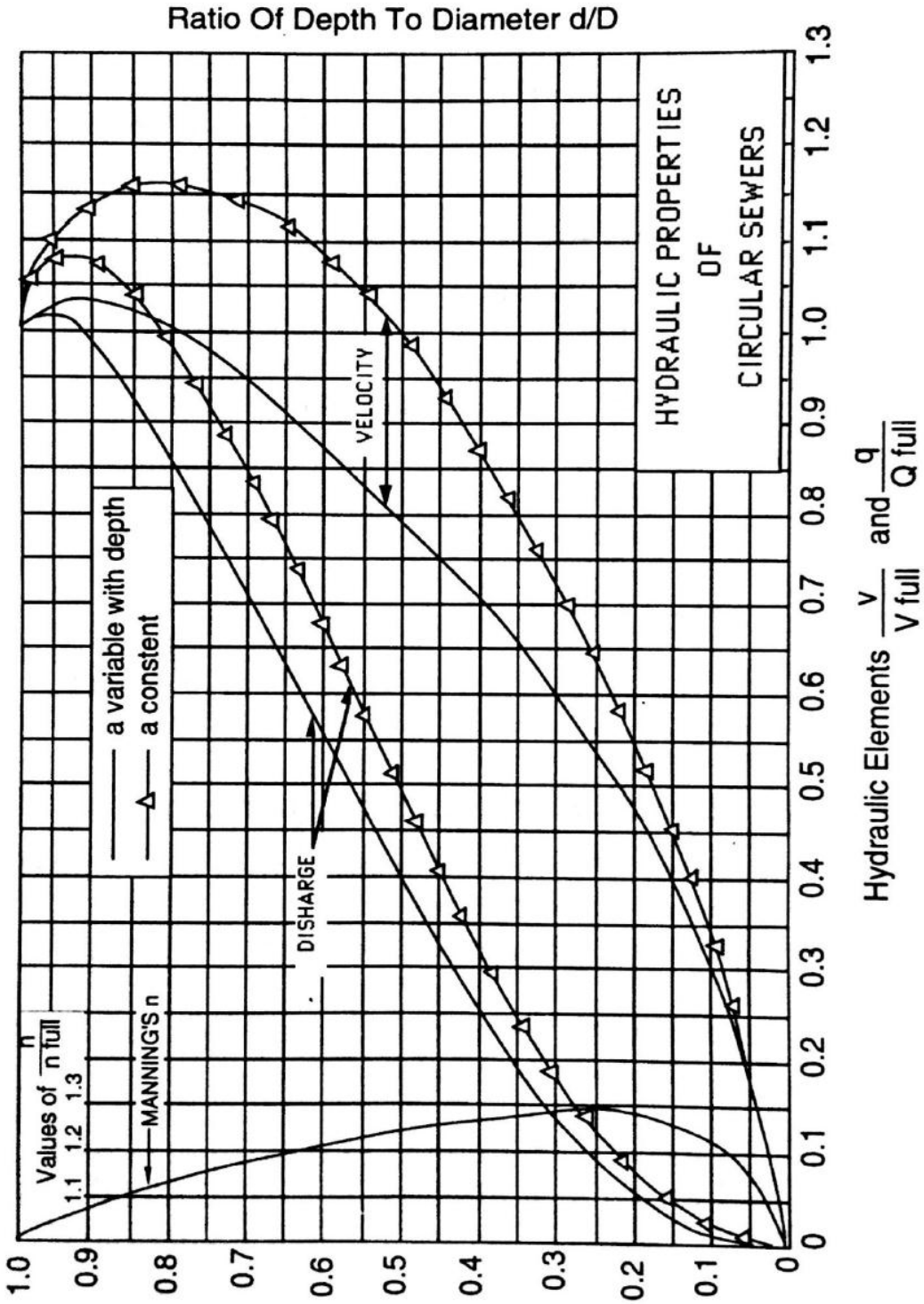
Ratio Of Depth To Diameter d/D
HYDRAULIC PROPERTIES OF CIRCULAR SEWERS
VELOCITY
DISHARGE
a variable with depth
a constent
MANNING'S n
Values of n/n full
1.1 1.2 1.3
Hydraulic Elements v/V full and q/Q full
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0

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