First Semester Examination
2019/2020 Academic Session

December 2019 / January 2020

EAP315 – Wastewater Engineering
(Kejuruteraan Air Sisa)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **TWELVE (12)** pages of printed materials including appendix before you begin the examination.

[*Sila pastikan kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions: This paper contains **FIVE (5)** questions. **PART A IS COMPULSORY**. Answer **THREE (3)** question in **PART B.** All questions carry the same marks.

***[Arahan**: Kertas ini mengandungi **LIMA (5)** soalan. **BAHAGIAN A WAJIB DIJAWAB**. Jawab **TIGA (3)** soalan daripada **BAHAGIAN B**. Semua soalan membawa jumlah markah yang sama.]*

You may answer the questions either in Bahasa Malaysia or in English.

[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.*]

In the event of any discrepancies, the English version shall be used.

[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*]

PART A: Compulsary (40 marks)

BAHAGIAN A: Wajib (40 markah)

(1). (a). Sketch typical weir of an up-flow circular sedimentation tank and describe its main purpose.

Lakarkan empang limpah tipikal suatu tangki enapan bulat aliran menaik dan terangkan tujuan utamanya.

[8 marks*/markah*]

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

Terdapat banyak parameter penting yang terlibat dalam reka bentuk tanki enap primer. Dengan bantuan lakaran dan dengan unit-unit yang sesuai, tuliskan hubung kait antara isipadu dan faktor kadaralir memasuki tangki, masa tahanan, kadar beban permukaan dan kadar empang limpah.

[9 marks/*markah*]

(c). With the help of a sketch drawing, propose and illustrate the design of any wastewater treatment system for a small community.

Dengan bantuan lakaran kasar, cadang dan jelaskan reka bentuk sebarang sistem olahan air sisa untuk komuniti kecil.

[8 marks*/markah*]

(d). Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are tools to measure the concentration of organic material in wastewater. Explain the concept of BOD value that is proportional to concentration of organic matter and discuss the differences between BOD and COD.

Keperluan Oksigen Biokimia (BOD) dan Keperluan Oksigen Kimia (COD) adalah alat untuk mengukur kepekatan bahan organik dalam air sisa. Jelaskan konsep nilai BOD yang berkadar dengan kepekatan bahan organik dan bincangkan perbezaan antara BOD dan COD.

[10 marks*/markah*]

(e). A sample of sewage is diluted by a factor of 8:100 using seeded dilution water. The initial DO of the diluted sample was 7.15 mg/L and the final DO after 5 days was 2.50 mg/L. The corresponding initial and final DO of the seeded dilution water was 7.55 mg/L and 7.00 mg/L, respectively. Calculate the BOD_5 of this sewage sample.

Sampel air sisa dilarutkan pada faktor 8:100 menggunakan air pencairan. DO awal dalam sampel yang dicairkan ialah 7.15 mg/L dan DO terakhir selepas 5 hari adalah 2.50 mg/L. DO awal dan akhir bagi air pencairan ialah masing-masing 7.55 mg/L dan 7.00 mg /L. Kirakan BOD_5 sampel air sisa tersebut.

[5 marks*/markah*]

PART B: Answer 3 out of 4 questions (20 marks each)

BAHAGIAN B: Jawab 3 dari 4 soalan (20 markah setiap satu)

(2). (a). Prove that the settling in a sedimentation tank is not influenced by the depth of the tank.

Buktikan bahawa pemendapan di tangki enapan tidak dipengaruhi oleh kedalaman tangki.

[8 marks*/markah*]

(b). A rectangular aerated grit chamber is having a peak flow of 50,000 m^3/day and a gravity flow through velocity at Q_{peak} of 0.2 m/s. If the length to width ratio of this tank is 3:1 and the width is twice the depth, determine:

Satu kebuk kersik berudara mempunyai kadaralir puncak 50,000 m^3/hari dan halaju aliran graviti pada Q_{puncak} 0.2 m/s. Jika nisbah panjang ke lebar tangki adalah 3:1 dan lebar tangki adalah dua kali kedalaman, tentukan:

(i). The width, length, and depth of the tank.

Lebar, panjang dan kedalaman tangki.

[6 marks/*markah*]

(ii). The quantity of grit generated per day. Assume the grit generation rate of 0.03 $m^3/10^3$ of wastewater.

Kuantiti kersik yang dijana sehari. Anggap kadar penjanaan kersik sebagai 0.03 $m^3/10^3$ air sisa.

[6 marks/*markah*]

(3). (a). Describe the Mixed Liquor Volatile Suspended Solids (MLVSS) in an activated sludge process in terms of:

Terangkan Pepejal Terampai Likur Tercampur dalam proses enap cemar teraktif dari segi:

(i). Definition
Definisi

[3 marks/*markah*]

(ii). Importance
Kepentingan

[2 marks/*markah*]

(iii). A brief measurement method.
Kaedah pengukuran ringkas

[5 marks/*markah*]

(b). An extended aeration wastewater treatment plant is to be designed based on the following data:
Volume = 1,500 m^3
Organic load = 1,600 kg/day
MLVSS = 2,000 mg/L
MLSS contains 60% organics

Determine the Food to Microorganism (F:M) ratio of this plant.

Suatu loji pengudaraan lanjutan perlu direka bentuk berdasarkan data berikut:
Isipadu = 1,500 m^3
Beban Organik = 1,600 kg/hari
MLVSS = 2,000 mg/L
MLSS mengandungi 60% organik

Tentukan nisbah Makanan ke Microorganism (F:M) loji ini.

[10 marks/*markah*]

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(4). (a). River has its own self-purification mechanism towards the pollution by self-cleansing. Discuss the self-cleansing process for a river.

Sungai mempunyai mekanisma pembersihan terhadap pencemaran secara swacuci. Bincangkan proses swacuci untuk sungai.

[10 marks/*markah*]

(b). If the maximum allowable flow velocity is 2.5 m/s and Manning roughness coefficient, n = 0.013, design the sewer size and slope to carry a flow of 0.16 m^3/s.

Jika halaju aliran maksimum yang dibenarkan adalah 2.5 m/s dan pekali kekasaran Manning, n = 0.013, reka bentuk saiz dan cerun pembetung untuk membawa aliran 0.16 m^3/s.

[10 marks/*markah*]

(5). (a). The increase in the cell size and cell mass during the development of organism is termed as growth pattern.

Peningkatan saiz sel dan jisim sel semasa pembentukan organisma dipanggil sebagai pola pertumbuhan.

(i). Sketch a cell growth curve pattern

Lakarkan graf lengkung pola pertumbuhan sel

[4 marks/*markah*]

(ii). Based on the sketch in (i), describe **THREE (3)** phases for dynamics of the bacterial growth.

*Berdasarkan lakaran dalam (i), terangkan **TIGA (3)** fasa sifat dinamik pertumbuhan bakteria.*

[6 marks/*markah*]

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(b). The 20 ºC BOD of a domestic wastewater at the end of 7 days was found to be 300 mg/L and the Ultimate BOD was 400 mg/L.

BOD 20 ºC air sisa pada akhir 7 hari didapati 300 mg/L dan BOD Muktamad adalah 400 mg/L.

(i). Determine the reaction rate constant (*k'*) at temperature of 20 ºC.
Tentukan pemalar kadar tindak balas (k') pada suhu 20 ºC.

[4 marks/*markah*]

(ii). Determine the 5-day BOD if the test was conducted at temperatures of 28 ºC. (Assume, Θ = 1.047).

Tentukan BOD hari ke-5 jika ujian dijalankan pada suhu 28 ºC. (Anggap, Θ = 1.047).

[4 marks/*markah*]

(iii). Compare the effect of reaction rate constant (*k'*) obtained at temperatures of 20 ºC and 28 ºC on the Ultimate BOD.

Bandingkan kesan pemalar kadar tindak balas (k') yang diperolehi pada suhu 20 ºC dan 28 ºC ke atas BOD Muktamad.

[2 marks/*markah*]

APPENDICES / *LAMPIRAN*

Peak Factor = $4.7\ p^{-0.11}$ (p in thousand)
Faktor Puncak = $4.7\ p^{-0.11}$ (p dalam ribu)

Retention time=Volume/discharge
Masa tahanan = Isipadu /kadaralir

Population Equivalent = $\frac{\text{Organic load from premises}}{\text{Organic load from 1 person}}$
Penduduk Setara = $\frac{\textit{Beban Organik Premis}}{\textit{Beban Organik 1 orang}}$

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 = $\frac{\text{(width of blade + opening)}}{\text{opening}}$ $\frac{\text{(Discharge)}}{\text{(velocity) (depth of wastewater)}}$
Lebar saring = $\frac{\textit{(Lebar bilah + saiz bukaan)}}{\textit{Saiz bukaan}}$ $\frac{\textit{(Kadaralir)}}{\textit{(Halaju) (Kedalaman air sisa)}}$

Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{\text{(Pumping rate-Dry Weather Flow)}}$
Sela pengepaman = $\frac{\textit{Isipadu sebenar}}{\textit{Kadaralir Cuaca Kering}} + \frac{\textit{Isipadu sebenar}}{\textit{(Kadar pam-Kadaralir Cuaca Kering)}}$

Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$
Kadar Beban Permukaan = $\frac{\textit{Kadaralir}}{\textit{Luas Permukaan}}$

Solids Loading Rate = $\frac{\text{(Discharge) (Mixed Liquor)}}{\text{Surface Area}}$
Kadar Beban Pepejal = $\frac{\textit{(Kadaralir) (Likur Tercampur)}}{\textit{Luas Permukaan}}$

Weir Loading Rate = $\frac{\text{Discharge}}{\text{Length of weir}}$
Kadar Beban Empang Limpah = $\frac{\textit{Kadaralir}}{\textit{Panjang Empang Limpah}}$

Volume of pyramid = (1/3) (base area) (height)
Isipadu Piramid = *(1/3) (luas dasar) (tinggi)*

Organic Load = (Discharge) (BOD)
Beban Organik = *(Kadaralir) (BOD)*

Keluasan Tangki enap primer = $\frac{\text{(Kadaralir + Kadaralir Pusing Balik) (Likur Tercampur)}}{\text{Fluks}}$

Fluks Pepejal = $\frac{\text{Halaju enapan}}{\text{(1/Kepekatan Pepejal) - (1/Kepekatan Pepejal Terenap)}}$

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

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

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

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

Beban Organik = (Kadaralir) (BOD)

Beban Organik Isipadu = $\frac{\text{(Kadaralir) (BOD)}}{\text{Isipadu}}$

Makanan: Microorganism = $\frac{\text{(Kadaralir) (BOD)}}{\text{(Isipadu) (Likur Tercampur)}}$

Beban Organik Kawasan = $\frac{\text{(Kadaralir) (BOD)}}{\text{Luas Permukaan}}$

Keperluan Oksigen = $\frac{Q \times BOD_5}{BOD_5/BOD_L}$ - 1.42 Px

Pertambahan Likur Tercampur = $\frac{y}{1+kd\theta c}$ (Kadaralir)(BOD)

Nisbah enap cemar kembali $R=\frac{\text{Kadaralir kembali}}{\text{Kadaralir}}$

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

Keperluan Oksigen = aLr + bSa

a = Pekali penyingkiran BOD

Lr = BOD tersingkir

b = pekali endagenous enap cemar

Sa = Jisim Likur Tercampur

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Kadar Bekalan Oksigen = $\frac{\text{Oksigen Diperlu}}{\text{BOD tersingkir}}$

Umur = $\frac{\text{(Isipadu) (Likur Tercampur)}}{\text{E.C. (Kadaralir Disingkir)(Likur Tercampur Pusing Balik) + (Kadaralir fluen)(Pepejal Terampai Efluen)}}$

$1/\theta = yu - k_d$

$\theta_c = \frac{V.MLSS}{Q_w.SS}$

Indeks Isipadu Enap cemar (SVI) = (Isipadu MLSS mengenap dalam 30 minit)/MLSS

Tangki Septik, C=225P

Pond design:

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

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

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

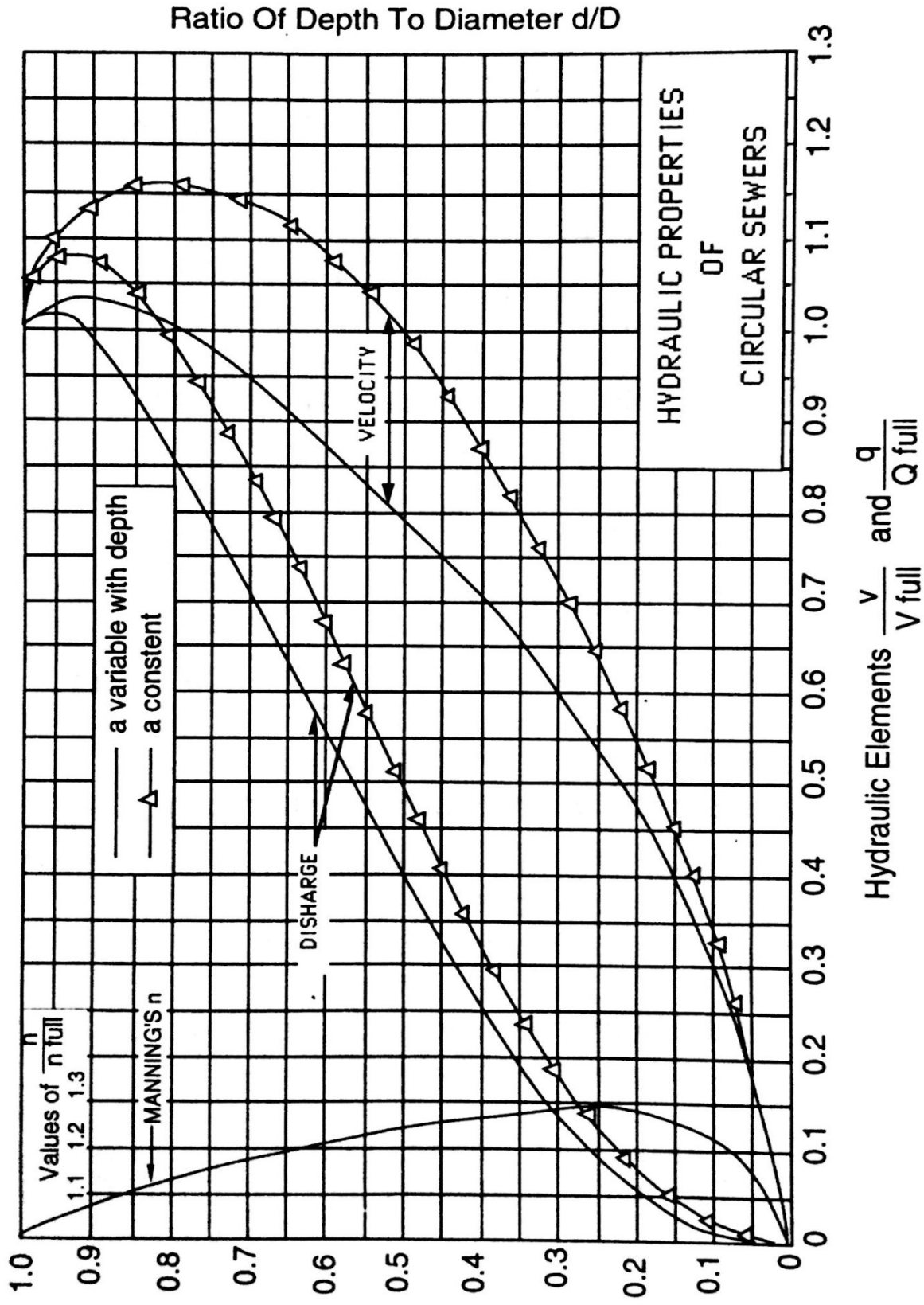
Organic Loading = L_iQ/A
Beban Organik = L_iQ/A

Maximum Organic Loading = $7.5 (1.054)^T$
Beban Organik Maksimum = $7.5 (1.054)^T$

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.


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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