UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

EAP 313/2 – Wastewater Engineering

[Kejuruteraan Air Sisa]

Duration: 2 hours
[Masa : 2 jam]

Please check that this examination paper consists of **FOURTEEN (14)** pages of printed material including appendix before you begin the examination.
*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: Answer **THREE (3)** questions only. Answer question 1 and any other **TWO (2)** questions. All questions carry the same marks.
*[**Arahan**: Jawab **TIGA (3)** soalan sahaja. Jawab sooalan 1 dan mana-mana **DUA (2)** soalan lain.Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new sheet.
*[Semua jawapan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. (a) Calculate the quantity of suspended solids production per person in gram per day from a locality of 1000 houses, suspended solids concentrations of 360mg/L and total flow of 1,200m^3/day.

[8 marks/*markah*]

Kira kuantiti penghasilan pepejal terampai setiap orang dalam gram sehari, dari suatu kawasan dengan kepekatan pepejal terampai 360mg/L dan jumlah kadaralir 1,200m^3/hari.

(b) Name the present guideline to be followed by the engineer in designing the wastewater treatment plant in Malaysia.

[4 marks/*markah*]

Namakan Garis Panduan terkini yang perlu dipatuhi oleh jurutera dalam mereka bentuk loji olahan air sisa di Malaysia.

(c) Using the given chart in Appendix, design a separate cast iron sewer which flows 65% full with gradient 0.35%. Take values of Qpeak to Qaverage ratio and Qaverage to Qminimum ratio as recommended in the Guidelines in (b). Designed population is 35,000 people.

[13 marks/*markah*]

Menggunakan Carta di Lampiran, reka bentukkan pembetung besi tuang yang mengalir 65% penuh dengan kecerunan 0.35%. Ambil nisbah Q puncak ke Q purata dan Q purata ke Q minimum seperti yang disyorkan dalam Garis Panduan dalam (b). Reka bentuk penduduk adalah 35,000 orang.

(d) A rectangular sedimentation tank is to be designed to treat a wastewater from 50,000 people. If the depth is 3m and retention time is 2 hours:

Suatu tangki enapan segi empat perlu di reka bentuk untuk mengolah air sisa dari 50,000 orang. Jika kedalaman tangki adalah 3 m dan masa tahanan 2 jam:

(i) Calculate the Surface Overflow Rate of this tank. Design at Q peak.

[8 marks/*markah*]

Kira Kadar Beban Permukaan tangki ini.

(ii) If the suspended solids is 400mg/L and the removal efficiency is 60%, calculate the quantity amount of sludge produced in m^3/day. Take the specific gravity of sludge as 1.06. Design at Q average.

[7 marks/*markah*]

Jika kepekatan pepejal terampai adalah 400mg/L dan kecekapan penyingkiran 60%, kira kuantiti enap cemar yang terhasil dalam m^3/hari. Ambil Graviti Tentu enap cemar sebagai 1.06. Reka bentuk pada Q purata.

2. (a) A small town discharges a wastewater flow of 1,000 m^3/day, BOD of 250 mg/L and treated with a a trickling filter treatment plant. The final effluent is discharged into a nearby river with minimum flow of 0.127m^3/s and BOD of 2.0mg/L. Calculate the BOD concentration downstream of the discharge point.

[8 marks/*markah*]

Sebuah bandar kecil melepaskan air sisa sebanyak 1,000 m^3/hari, BOD sebanyak 250 mg/L dan diolah menggunakan loji turas cucur. Efluen akhir dilepaskan ke sungai berhampiran yang berkadaralir 0.127m^3/s dan BOD 2.0mg/L. Kira kepekatan BOD di hilir titik pelepasan.

(b) With the help of a sketch, define briefly self purification of a river.

[6 marks/*markah*]

Dengan bantuan lakaran, definisikan secara ringkas prinsip swacuci sebuah sungai.

(c) A secondary treatment plant is having the following design data:

Dry Weather Flow = 1,000m^3/day

Ratio of Length: Width = 3:1

Width = 5m

Retention time = 2 hours

Mixed Liquor Suspended Solids = 3,000mg/L

Calculate:

(i) Depth of tank [5 marks/*markah*]

(ii) Solids Loading Rate in kg/m^2.day [5 marks/ *markah*]

Suatu loji olahan sekunder mempunyai data reka bentuk seperti berikut:

Kadaralir Puncak = 1,000m^3/hari

Nisbah Panjang:Lebar = 3:1

Lebar= 5m

Masa tahanan = 2 hours

Likur Tercampur Pepejal Terampai = 3,000mg/L

Kira:

(i) Kedalaman tangki

(ii) Kadar Beban Pepejal dalam kg/m^2.hari

(d) Prove that the design of sedimentation tank does not influence by depth.

[6 marks/*markah*]

Buktikan bahawa kedalaman tangki tidak mempengaruhi reka bentuk tangki enapan.

3. (a) Given **THREE (3)** sample of wastewater, sample A from paper mill factory with BOD_5^{30} 225mg/L, sample B from meat packing factory with BOD_5^{30} 200mg/L and sample C from livestock compound with BOD_5^{30} 175mg/L. The BOD rate constant at temperature 20°C are 0.16 day^{-1} for sample A, 0.12 day^{-1} for sample B and 0.08 day^{-1} for sample C.

*Diberi **TIGA (3)** sampel air kumbahan, sampel A daripada kilang membuat kertas dengan BOD_5^{30} 225mg/l, sample B daripada kilang pembungkusan daging dengan BOD_5^{30} 200mg/l dan sample C daripada pusat penternakan dengan BOD_5^{30} 175mg/l. Pekali kadar BOD pada suhu* 20°C adalah *0.16 $hari^{-1}$ bagi sample A, 0.12 $hari^{-1}$ bagi sample B, 0.08 $hari^{-1}$ bagi sample C.*

(i) Which one of that wastewater will have a fastest oxidizing process and what is the factor that makes it is consider the fastest.

[2 marks/*markah*]

Mana satukah antara air kumbahan tersebut mempunyai process pengosidaan yang terpantas dan apakah faktor yang membuatkan ia dianggap terpantas.

(ii) Determine the 1-day BOD for sample A if conducted at temperature 25°C

[10 marks/*markah*]

Tentukan BOD 1-hari bagi sample A sekiranya dilakukan pada suhu 25°C

(b) What are the difference of digested sludge characteristics between source from Aerobic Digester and Anaerobic Digester in terms of colour and odour.

[6 marks/*markah*]

Apakah perbezaan ciri enapcemar tercerna antara daripada sumber Pencerna Aerobik dan Pencerna Anaerobik dari segi warna dan bau.

(c) If disposal of wastewater sludge into secure landfill is not allowed by the government because of lack of available landfill area, NAME **TWO (2)** other options for ultimate sludge disposal.

[2 marks/*markah*]

*Sekiranya pelupusan enapcemar sisa kumbahan ke dalam tapak pelupusan sampah tidak lagi dibenarkan oleh kerajaan kerana masalah kekurangan kawasan pelupusan sampah, NAMAKAN **DUA (2)** opsyen pelupusan muktamad erap cemar.*

(d) Calculate the quantity of oxygen required for a given aeration tank design with design data as follows:

Organic load = 250kg/day

MLSS = 3,000mg/L

y = 0.6mg/mg

kd = $0.05day^{-1}$

θc = 9 days

Only 65% BOD is degraded on day 5

[10 marks/*markah*]

(d) Kira kuantiti oksigen yang diperlukan oleh suatu tangki pengudaraan dengan data reka bentuk seperti berikut:

Beban organik = 250kg/hari

MLSS = 3,000mg/L

y = 0.6mg/mg

kd = 0.05 day^{-1}

θc = 9 hari

Hanya 65% BOD terurai pada hari ke 5

4. (a) Sketch a process flow diagram of an extended aeration activated sludge system.

[6 marks/*markah*]

Lakarkan rajah proses kadaralir untuk suatu sistem enap cemar teraktif pengudaraan lanjutan

(b) A wastewater treatment plant is to be designed based on the following data:

Population equivalent = 100,000

BOD rate = 55 gram/capita.day

Design at Dry Weather Flow

Suatu loji olahan air sisa perlu direka bentuk berdasarkan data berikut:

Penduduk Setara= 100,000

Kadar BOD = 55 gram/kapita.hari

Reka bentuk pada Kadaralir Cuaca Kering

(i) Calculate the Volumetric Organic Loading and the Aerial Organic Loading of a cylindrical trickling filter with diameter 5m and depth 10m. Assume the net volume of filter is 50% of the total volume.

[12 marks/*markah*]

Kira Beban Organik Isipadu dan Beban Organik Kawasan suatu turas cucur selinder dengan diameter 5 m dan kedalaman 10m. Anggap isipadu bersih turas adalah 50% dari isipadu jumlah..

(ii) Determine the Food to Microorganism (F:M) ratio of an extended aeration activated sludge system if the retention time is 8 hours and the MLSS concentration is 2500mg/L.

[12 marks/*markah*]

Tentukan nisbah Makanan: Mikroorganisma suatu sistem enap cemar teraktif pengudaraan lanjutan jika masa tahanan 8 jam dan kepekatan MLSS 2,500mg/L.

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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 = $\frac{\text{(Discharge) (Mixed Liquor)}}{}$

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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 = $\frac{\textit{(Kadaralir + Kadaralir Pusing Balik) (Likur Tercampur)}}{\text{Fluks}}$

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 = $\frac{\textit{(Kadaralir) (BOD)}}{\textit{Isipadu}}$

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

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

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

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

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

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

$$\text{Keperluan Oksigen} = aLr + bSa$$

a = Pekali penyingkiran BOD

Lr = BOD tersingkir

b = pekali endagenous enap cemar

Sa = Jisim Likur Tercampur

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

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

$1/\theta = yu - k_d$

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

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

Tangki Septik, C=225P

Pond design:

$L_e/L_i = 1/(1+k_1 t)$

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

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

Organic Loading = $L_i Q/A$

Beban Organik = $L_i Q/A$

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

Beban Organik Maksimum = $7.5 (1.054)^T$

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Jadual Penduduk Setara

(Dipetik dari MS 1228 : 1991 : MALAYSIAN STANDARD: Code of Practice for Design and Installation of Sewerage Systems) dan Guidelines for Developers, Seksyen 1 dan 2, 1995

No	*Jenis Premis*	*Penduduk Setara (dicadangkan)*
1	*Kediaman*	*5 per unit**
2	*Komersial (termasuk pusat hiburan/rekreasi, kafeteria, teater)*	*3 per 100 m^2 kawasan kasar*
3	*Sekolah/InstitusiPengajian :* *- Sekolah/institusi siang* *- Dengan asrama penuh* *- Dengan sebahagian asrama*	 *0.2 per pelajar* *1 per pelajar* *0.2 per pelajar untuk pelajar tanpa asrama* *1 per pelajar untuk penduduk asrama*
4	*Hospital*	*4 per katil*
5	*Hotel (dengan kemudahan masakan dan cucian pakaian)*	*4 per bilik*
6	*Kilang (tidak termasuk sisa yang diproses)*	*0.3 per pekerja*
7	*Pasar (jenis basah)*	*3 per gerai*
8	*Pasar (jenis kering)*	*1 per gerai*
9	*Stesyen petrol/Perkhidmatan*	*15 per tandas*
10	*Stesyen bas*	*4 per petak bas*
11	*Stesyen teksi*	*4 per petak teksi*
12	*Mesjid*	*0.2 per orang*
13	*Gereja/Kuil*	*0.2 per orang*
14	*Stadium*	*0.2 per orang*
15	*Kolam renang/Kompleks sukan*	*0.5 per orang*
16	*Tandas awam*	*15 per tandas*
17	*Lapangan terbang*	*0.2 per petak penumpang* *0.3 per pekerja*
18	*Laundri*	*10 per mesin*
19	*Penjara*	*1 per orang*
20	*Padang golf*	*20 per lubang*

** 1 kadaralir adalah setara dengan 225 liter/kapita/day*

Table A.1 Recommended Population Equivalent

Type of Premises/Establishment	Population Equivalent (Recommended)
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	0.2 per person
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 bay 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf course	20 per hole

Water consumption rate = 225 liter/capita.day

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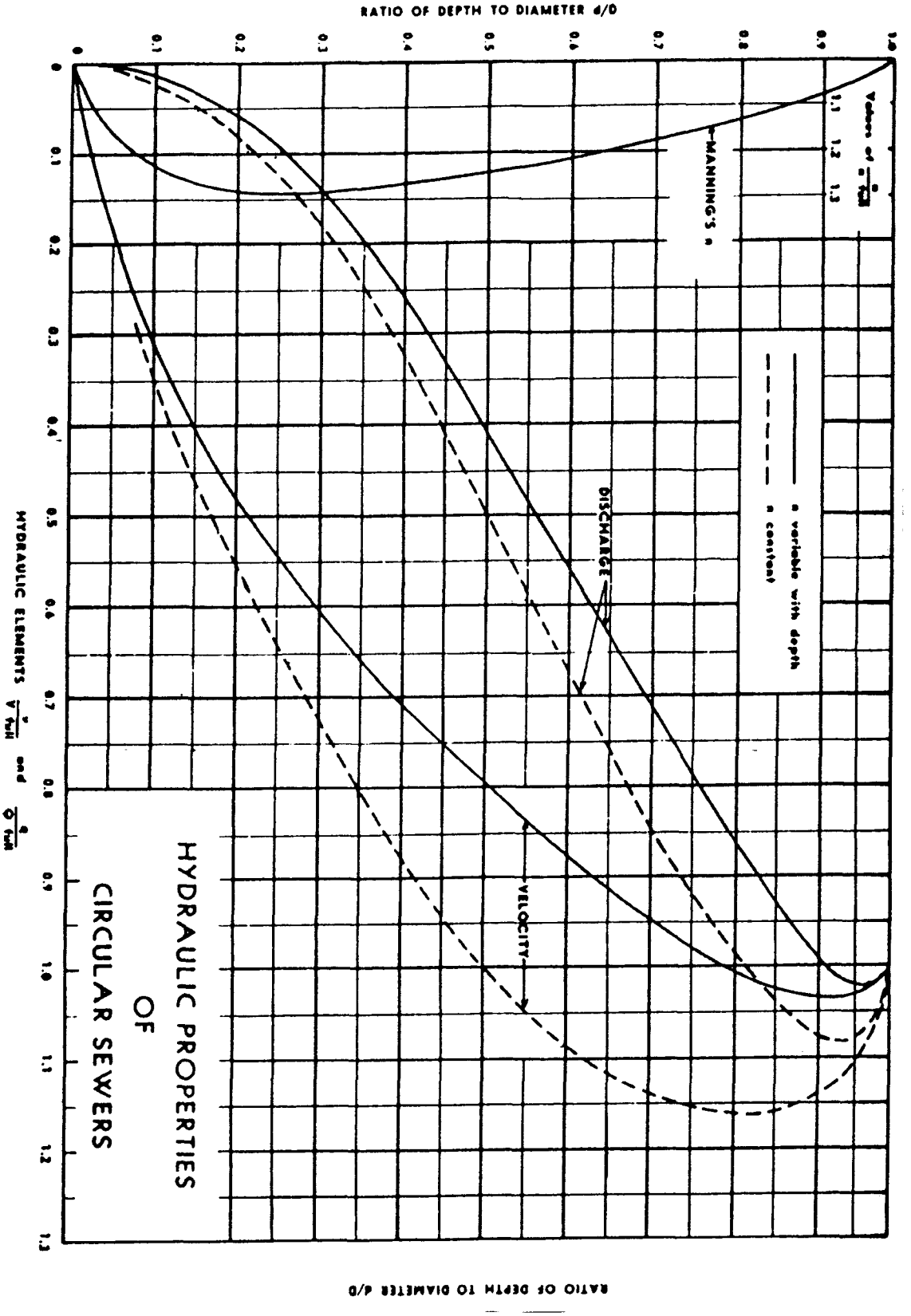
RATIO OF DEPTH TO DIAMETER d/D
HYDRAULIC ELEMENTS v/v full and q/q full
RATIO OF DEPTH TO DIAMETER d/D
HYDRAULIC PROPERTIES
OF
CIRCULAR SEWERS
DISCHARGE
VELOCITY
n variable with depth
n constant
MANNING'S n