UNIVERSITI SAINS MALAYSIA

First Semester Examination
2007/2008 Academic Session

October / November 2007

EAP 313/2 – Wastewater Engineering
[Kejuruteraan Air Sisa]

Duration : 2 hours
[Masa : 2 jam]

Please check that this examination paper consists of THIRTEEN pages of printed material including appendices before you begin the examination.
[Sila pastikan kertas peperiksaan ini mengandungi TIGA BELAS muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]

Instructions: Answer QUESTION 1 **(COMPULSORY)** and ANY OTHER 2 QUESTIONS.
*[Arahan: Jawab SOALAN 1 **(WAJIB)** dan MANA-MANA 2 SOALAN LAIN.*

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) Sketch the buffer zone requirement between a wastewater treatment plant and housing area for:

(i) Open plant
(ii) Close plant

(6 marks)

Lakarkan syarat zon penampan di antara loji olahan air sisa dan kawasan perumahan untuk:

(i) Loji tertutup
(ii) Loji terbuka

(b) A town is having a peak wastewater flow of 1,600 m^3/day with water consumption rate of 33,750 liter/house/month. Calculate the population equivalent of this town.

(8 marks)

Sebuah bandar mempunyai kadaralir airsisa puncak sebanyak 1,600 m^3/hari dan kadar penggunaan air sebanyak 33,750 liter/rumah/bulan. Kirakan penduduk setara bandar ini.

(c) Briefly, explain the following:

(i) The meaning of volatile suspended solid (VSS).

(2 marks)

(ii) Measurement method in laboratory.

(4 marks)

(iii) The importance in wastewater treatment.

(2 marks)

Secara ringkas terangkan;

(i) Pengertian pepejal terampai meruap (VSS).

(ii) Kaedah penentuan di makmal.

(iii) Kepentingannya dalam olahan air sisa.

1. (d) A wastewater from a new housing scheme with population of 1,000 people is to be treated by a physical process using a rectangular primary sedimentation tank. If the weir loading rate is 1,000 m^3/m.day and average flow is 250 m^3/day, determine the length of the tank if ratio of length to width is 3:1.

(8 marks)

Suatu air sisa dari kawasan perumahan baru dengan penduduk setara 1,000 perlu melalui proses olahan fizikal menggunakan tangki enap primer segiempat. Sekiranya beban empang limpah adalah 1,000 m^3/m.hari dan kadaralir purata 250 m^3/hari, tentukan panjang tangki, sekiranya nisbah panjang:lebar adalah 3:1.

(e) Given the BOD_5 of a domestic wastewater is 250 mg/L. The wastewater comes from a housing scheme (500 houses) and one daily school with 800 students. If the water consumption rate is 225 liter/capita.day, calculate:

(i) The appropriate organic loading of a Rotating Biological Contactor (RBC).

(6 marks)

(ii) The surface area of a trickling filter with depth 3 meter and the volumetric organic loading 0.8 kg BOD_5/m^3. day.

(4 marks)

Diberi nilai BOD_5 suatu air sisa domestik adalah 250 mg/L. Air sisa tersebut datangnya dari suatu skim perumahan (500 rumah) serta sebuah sekolah harian dengan pelajar 800 orang. Jika kadar penggunaan air adalah 225 liter/kapita.hari, kirakan:

(i) Nilai beban organik loji Penyentuh Biologi Berputar (RBC) yang sesuai.

(ii) Luas permukaan turas cucur berkedalaman 3 meter serta mempunyai Beban Organik Isipadu 0.8 kg BOD_5/m^3. hari.

2. (a) A sewer system flows a wastewater from a housing scheme with data as given in Table 1:

Table 1: Design data

Premis type	Data
Single storey medium cost house	2,750
Double storey semi-detached house	100
Double storey shop house Ground floor – 6.1m x 12.65m First floor – 6.1m x 15.54m	50
Petrol station	1
Day school @ 1,300 pupils	1
Mosque @ 1,000 people	1

Design a cast iron separate sewer (n=0.013) which flows 60% full at $Q_{maximum}$. Allowable slope is 1:500. Assume ratio $Q_{maximum}$ to $Q_{average}$ and $Q_{average}$ to $Q_{minimum}$ are 3.5 and 0.3, respectively. Self cleansing velocities of wastewater are given in Table 2.

Table 2: Self cleansing velocity of wastewater

Diameter (mm)	Halaju (m/s)
150-250	1.00
300-600	0.75
>600	0.60

(22 marks)

2. (a) *Suatu sistem pembetung perlu mengalirkan 80% daripada air sisa dari kawasan perumahan berdasarkan data seperti di Jadual 1:*

Jadual 1: Data reka bentuk

Jenis Premis	*Data*
Rumah 1 tingkat kos sederhana	*2,750*
Rumah berkembar 2 tingkat	*100*
Rumah kedai 2 tingkat *Paras lantai – 6.1m x 12.65m* *Tingkat 1 – 6.1m x 15.54m*	*50*
Stesyen minyak	*1*
Sekolah harian @ 1,300 murid	*1*
Masjid @ 1,000 orang	*1*

Reka bentukkan sebuah pembetung terasing jenis besi tuang (n=0.013) yang mengalir 60% penuh pada $Q_{maksimum}$. Kecerunan yang dibenarkan ialah 1:500. Anggap nisbah Q_{puncak} terhadap Kadaralir Cuaca Kering serta Kadaralir Cuaca Kering terhadap $Q_{minimum}$ adalah masing-masing 3.5 dan 0.3.

Halaju swabersih air sisa adalah berpandukan nilai dalam Jadual 2.

Jadual 2: Halaju swabersih air sisa

Diameter (mm)	***Halaju (m/s)***
150-250	*1.00*
300-600	*0.75*
>600	*0.60*

2. (b) Determine suitable screen size for wastewater in (a) if he approaching velocity is 0.85 m/s, bar width is 10 mm and opening is 25 mm.

(8 marks)

Tentukan saiz penyaring yang sesuai untuk air sisa dalam (a) sekiranya halaju tuju adalah 0.85 m/s, lebar bilah 10 mm dan saiz bukaan 25 mm.

3. (a) Sketch process flow diagram of a 2-series facultative oxidation pond.

(6 marks)

Lakarkan rajah kadaralir kolam pengoksidaan fakultatif 2 siri.

(b) A facultative oxidation pond is to be designed based on the following technical data:

Population Equivalent 5,000
Temperature 25°C
Depth 1.75 m
Incoming BOD 250 mg/L
Final BOD discharge limit 50 mg/L

Calculate the surface area of this pond.

(10 marks)

Suatu kolam fakultatif perlu dibina berdasarkan data teknikal berikut:

Penduduk Setara 5,000
Suhu 25°C
Kedalaman 1.75 m
BOD masuk 250 mg/L
Had pelepasan BOD akhir 50 mg/L

Kirakan luas permukaan kolam ini.

3. (c) Prove that in an activated sludge process, $x_a = x_R (1/1+R)$, where x_a = MLSS, x_R = recycled sludge concentration R=ratio of recycled sludge.

(8 marks)

Buktikan bahawa dalam proses enap cemar teraktif, , $x_a = x_R (1/1+R)$, di mana x_a = MLSS, x_R = kepekatan enap cemar pusing balik dan R= nisbah enap cemar pusing balik.

(d) A wastewater treatment plant has a flow rates equivalent to 5,000 people. If the MLSS of the aeration basin is 3,500 mg/L and the recycled flow rate from the secondary sedimentation tank is 300 m^3/day, calculate the required concentration of sludge to be recycled to the aeration basin to maintain the MLSS concentration of this basin.

(6 marks)

Suatu loji olahan air sisa mempunyai kadaralir bersamaan 5,000 orang. Jika MLSS di tangki pengudaraan adalah 3,500 mg/L dan kadaralir pusing balik dari tangki enap sekunder adalah 300 m^3/hari, kirakan kepekatan enap cemar yang perlu dipusing balik ke tangki pengudaraan untuk mengekalkan kepekatan MLSS di tangki ini.

4. (a) Sketch the BOD reaction curve for high carbohydrated wastewater compared with oily wastewater.

(5 marks)

Lakarkan lengkok penguraian BOD untuk air sisa berkabohidrat tinggi berbanding air sisa berminyak.

4. (b) A 8.0 mL sample of wastewater is diluted to 300 mL with distilled water in a standard biochemical oxygen demand (BOD) bottle. The initial dissolved oxygen (DO) in the bottle is determined to be 7.5 mg/L, and the DO after 5 days at 20^0C is found to be 1 .5 mg/L.

(i) Determine the BOD_5 of the wastewater.

(5 marks)

(ii) Compute its ultimate BOD (BOD_L). Assume that k = 0.5/d

(5 marks)

(iii) What is the difference between:
(1) aerobic and anaerobic decay
(2) anaerob and facultative bacteria
(3) heterotrophic and an autotrophic organism

(15 marks)

Sebanyak 8.0 ml sampel air sisa di dalam botol piawai BOD dicairkan menjadi 300 ml menggunakan air suling. Nilai awal oksigen terlarut (DO) didapati sebanyak 7.5 mg/L dan DO selepas 5 hari pada suhu 20°C diperolehi sebanyak 1.5 mg/L.

(i) Tentukan BOD_5 bagi sampel air tersebut.

(ii) Kirakan BOD penghabisan (BOD_L) bagi sampel air tersebut. Andaian: nilai k = 0.5/d.

(iii) Apakah perbezaan di antara;
(1) pereputan aerobik dan anaerobik
(2) bakteria anaerob dan bakteria fakultatif
(3) organisma heterotrofik dan autotrofik

APPENDICES

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 = $\frac{\text{Beban Organik Premis}}{\text{Beban Organik 1 orang}}$

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 = $\frac{\text{(Lebar bilah + saiz bukaan)}}{\text{Saiz bukaan}} \frac{\text{(Kadaralir)}}{\text{(Halaju) (Kedalaman air sisa)}}$

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

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

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

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

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

...9/-

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=$\frac{\text{Kadaralir kembali}}{\textit{Kadaralir}}$

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

Keperluan Oksigen = aLr + bSa

a = Pekali penyingkiran BOD

Lr = BOD tersingkir

b = pekali endagenous enap cemar

...10/-

Sa = Jisim Likur Tercampur

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

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

$1/\theta = yu - k_d$

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

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 = $7.5 (1.054)^T$

...11/-

APPENDICES

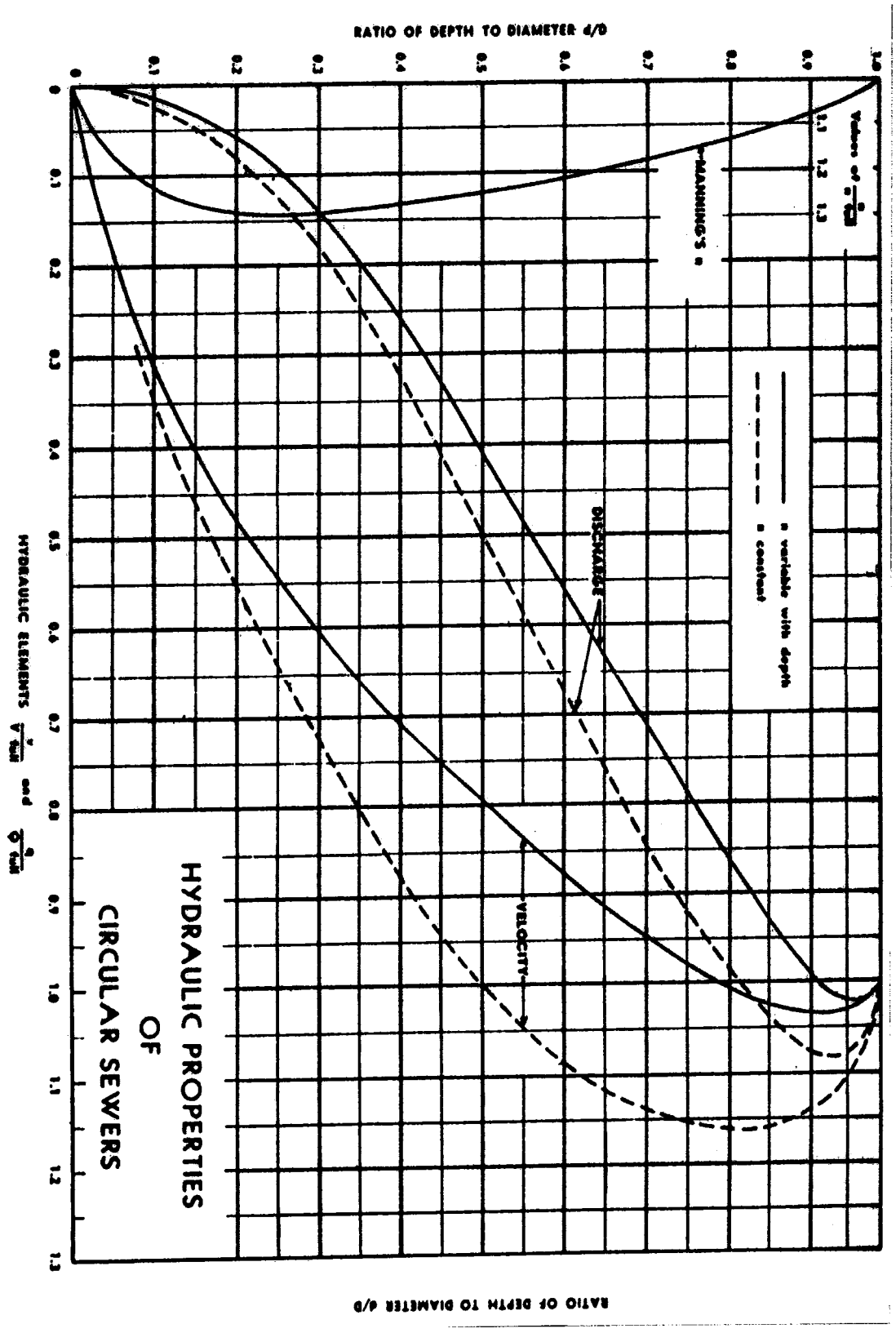
Jadual Penduduk Setara

(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	SekolahInstitusiPengajian : - 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

APPENDICES


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

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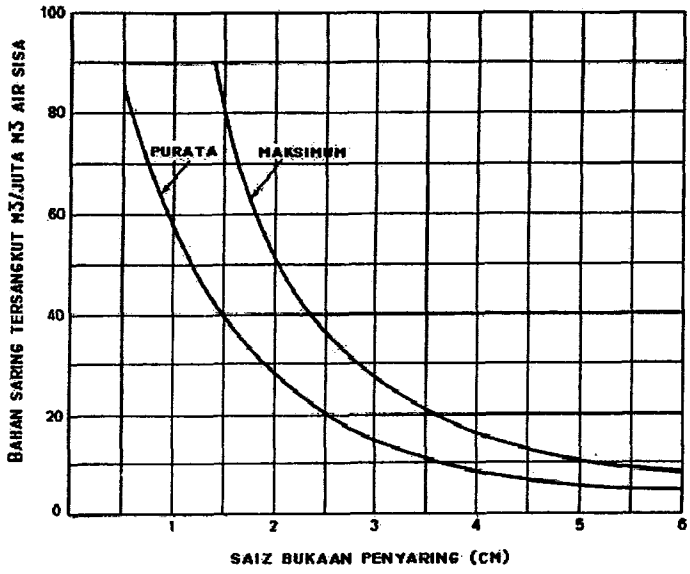

Screen designing chart
Carta reka bentuk penyaring

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