UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	ENVIRONMENTAL ENGINEERING
COURSE CODE	:	BFC 3103 / BFC 32403
PROGRAMME	:	BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FOURTEEN (14)** PAGES

Q1 (a) Define the Standard A and Standard B maximum permitted value in Third Schedule of Environmental Quality Act, 1974 under the Environmental Quality (Sewage and Industrial Effluent) Regulation, 1979.

(2 marks)

(b) Explain briefly the essence in each of the following acts:

(i) National Ambient Air Quality Standards

(ii) Recommended Malaysian Air Quality Standards

(4 marks)

(c) (i) Explain the effects of industrialization to the environment.

(3 marks)

(ii) By giving **one (1)** example of industry, propose air quality control devices and prevention methods to overcome its particulate emission problem.

(4 marks)

(d) Acid rain is always related to the deterioration of environmental quality. Provide suggestions to reduce this problem.

(6 marks)

(e) Evaluate the problem of air pollution between urban and rural area.

(6 marks)

Q2 (a) River A is joined by River B and River C to form River D. The flows and ultimate BOD_5 for these rivers are listed below in **Table 1**. Determine the initial ultimate BOD after mixing of the River D.

Table 1

Source	Flow (m^3/s)	Ultimate BOD (mg/L)	Temperature (^0C)
River A	0.252	27	20
River B	0.130	8	20
River C	0.020	16	20

(3 marks)

(b) A step in anaerobic decomposition of organic wastes produces acetic acid (CH_3COOH). Determine the theoretical oxygen demand (ThOD) of 300 mg/L of acetic acid. Assume the following reaction applies

$$CH_3COOH + 2O_2 = 2CO_2 + H_2O$$

(5 marks)

(c) With the aid of illustration, define oxygen deficit and explain briefly the **five (5)** zones of DO sag that involve in self-purification system when discharge of pollutants occurred in the river.

(7 marks)

(d) By using Thomas graphical method and the following data tabulated in **Table 2**:

Table 2

Time (day)	BOD (mg/L)
2	70.0
5	102.4
7	111.0
8	114.0
10	118.8

(i) Plot graph $\left[\frac{t}{BOD_t}\right]^{1/3}$ versus time

(ii) Calculate the BOD rate constant, k

(iii) Calculate the ultimate BOD, L_o

(10 marks)

Q3 (a) (i) A filter was run for water treatment is terminated as a result of either one of two condition. Briefly explain both conditions.

(2 marks)

(ii) During the disinfection process of treated water, differentiate between free available chlorine (FAC) and combined available chlorine (CAC).

(2 marks)

(b) Summarize the coagulation process in water treatment with respect to the destabilization and favorable coagulant.

(5 marks)

(c) (i) Prove that 0.26 mg/L of alum sludge is removed for each 1 mole/L alum used by using the chemical reaction as :

$$Al_2(SO_4)_3 \cdot 14H_2O + 6HCO_3^- \leftrightarrow 2Al(OH)_3(s) + 6CO_2 + 8\,H_2O + 3SO_4^{2-} + 14H_2O$$

(5 marks)

(ii) By using the answer Q3(c)(i), calculate the amount of sludge(in g/d) if the flow rate is 4000 m^3/d.

(2 marks)

(d) A circular clarifier is being used to remove suspended solid in the water. Design the circular clarifier using the design criteria as follows:

-design flow = 1000 m^3/d
- retention time = 3 hrs
- diameter to depth ratio = 1.5 : 1
- weir length = 10 m

Give comments on your answer regarding to the following:
- surface over flow rate = 20- 35 $m^3/day/m^2$
- weir overflow rate = 150 – 300 m^3 /day/m

(9 marks)

Q4 (a) Differentiate between the attached growth and suspended growth system of biological treatment of wastewater and gives example of each system.

(2 marks)

(b) Name **two (2)** processes unit under each of the following treatment unit and discuss the function of each process:

(i) Pretreatment
(ii) Tertiary Treatment

(6 marks)

(c) A grit chamber is designed to treat a wastewater (22°C) with an overflow rate of 4752m^3/m^2.d. By using Stokes's Law, calculate the time required by a 0.2 mm diameter sand particles (ρ = 2.15 g/cm^3) to settle at the bottom of the tank. If the depth of the grit chamber is 0.9m, what will be the length?

(6 marks)

(d) The following data were reported on the operation of primary sedimentation tank and activated sludge system in treating a wastewater

Primary Sedimentation Tank

	Influent	Removal Efficiency
BOD	150mg/L	35%
Suspended Solid	275 mg/L	60%

Activated Sludge System
with 90% removal efficiency for BOD and Suspended Solid operates under the following conditions:

Flow	: 0.08m^3/s
Aeration Tank Dimension	: 7.5 wide, 30m long, 4m deep (2 tanks are operated in series)

Mixed Liquor Volatile Suspended Solid : 3000 mg/L
Return Flow : $0.03 m^3/s$
Waste Sludge Concentration : 6000 mg/L
Waste Sludge Flow : $0.001 m^3/s$

Calculate:

(i) Hydraulic Retention Time
(ii) F/M ratio
(iii) Mean cell residence time

(11 marks)

Q5 (a) Define Municipal Solid Waste (MSW) and list **two (2)** of its components.

(2 marks)

(b) (i) Discuss the importance of source separations of MSW.

(3 marks)

(ii) From your point of view, how the MSW source separation at home, schools, industries and other premises/institutions can be achieved in Malaysia in the near future?

(3 marks)

(c) The components of solid waste sample are shown in the **Table 3** below:

Table 3

Component	Percent by mass	Moisture content (%)
Garden trimmings	25	60
Food waste	40	70
Plastics	6	2
Wood	15	20
Cardboards	7	5

Calculate the dry mass in kg of each component based on 100 kg and overall moisture content of the solid waste sample.

(6 marks)

d) A residential city of 200,000 homes generates 0.95 kg/person.day of municipal solid waste. On average each house is occupied by 6 people.

(i) How much MSW is generated per day?

(1 mark)

(ii) If the compacted density of solid waste in collection vehicle is 325 kg/m^3, determine the compacted volume of solid waste to be collected per week.

(2 marks)

(iii) If the collection vehicle capacity is 50 m^3, determine the number of trips per week.

(2 marks)

(iv) Determine the average numbers of residence from which wastes are to be collected for each trip.

(1 mark)

(v) A landfill is used to serve the city. The landfill volume used is 11.50 x 10^6 m^3, the compacted waste density is 490 kg/m^3, and the ratio of soil cover/compacted waste is 1.9. If 67% of the landfill has been used, calculate the life remaining of the landfill (in years)?

(5 marks)

S1 (a) Definisikan Piawai A dan Piawai B nilai maksimum yang dibernarkan dalam Jadual Ketiga Akta Kualiti Alam Sekeliling 1974 di bawah Peraturan Kualiti Alam Sekeliling (Pembentungan dan Efluen Industri) 1979.

(2 markah)

(b) Terangkan secara ringkas bagi setiap yang berikut:
(i) Piawaian Kualiti Udara Negara
(ii) Piawaian Kualiti Udara Malaysia yang dicadangkan

(4 markah)

(c) (i) Terangkan kesan-kesan perindustrian ke atas alam sekitar.

(3 markah)

(ii) Dengan memberikan satu contoh industri, cadangkan peranti kawalan kualiti udara dan kaedah pencegahan untuk mengatasi masalah pencemaran zarahan.

(4 markah)

(d) Hujan asid biasa dikaitkan dengan penyusutan kualiti alam sekitar. Sediakan beberapa cadangan bagi membantu mengurangkan masalah ini.

(6 markah)

(e) Nilaikan masalah pencemaran udara yang dihadapi antara kawasan bandar dan luar bandar.

(6 markah)

S2 (a) Sungai A dan Sungai B bergabung membentuk Sungai C dan akhirnya menjadi Sungai D. Kadar alir dan nilai BOD_5 muktamad untuk kesemua sungai disenaraikan di **Jadual 1** seperti di bawah. Kirakan nilai muktamad BOD awal setelah percampuran di Sungai D.

Jadual 1

Punca	Kadar alir (m^3/s)	BOD muktamad (mg/L)	Suhu (^0C)
Sungai A	0.252	27	20
Sungai B	0.130	8	20
Sungai C	0.020	16	20

(3 markah)

(b) Di dalam satu langkah penguraian sisa bahan organik secara anaerobik akan menghasilkan asetik asid (CH_3COOH). Tentukan nilai ThOD yang mengandungi 300 mg/L asetik asid. Andaikan persamaan yang berikut berlaku:

$$CH_3COOH + 2O_2 = 2CO_2 + H_2O$$

(5 markah)

(c) Dengan bantuan gambarajah, definisikan pengurangan oksigen dan jelaskan dengan ringkas **lima (5)** zon suatu lendut oksigen yang terlibat di dalam system penyucian kendiri apabila bahan tercemar dibuang ke dalam sesebuah sungai.

(7 markah)

(d) Dengan menggunakan kaedah graf Thomas dan nilai di **Jadual 2**:

Jadual 2

Masa (hari)	BOD (mg/L)
2	70.0
5	102.4
7	111.0
8	114.0
10	118.8

(i) Plokan graf $\left[\frac{t}{BOD_t}\right]^{1/3}$ melawan masa

(ii) Kirakan pemalar kadar tindakbalas, k

(iii) KIrakan nilai muktamad BOD, L_o

(10 markah)

S3 (a) (i) Operasi sebuah penapis dalam perawatan air terhenti akibat salah satu daripada dua keadaan. Bincangkan dengan ringkas kedua-dua keadaan tersebut.

(2 markah)

(ii) Dalam proses pembasmian kuman semasa perawatan air, bezakan klorin boleh dapat percuma dan klorin boleh dapat gabungan.

(2 markah)

(b) Rumuskan proses koagulasi dalam rawatan air terhadap faktor penyahstabilan dan bahan pengental.

(5 markah)

(c) (i) Buktikan bahawa 0.26 mg/L enapcemar alum tersingkir bagi penggunaan 1 mol/L alum dengan menggunakan tindakbalas kimia berikut:

$$Al_2(SO_4)_3 \cdot 14H_2O + 6HCO_3^- \leftrightarrow 2Al(OH)_3(p) + 6CO_2 + 8\ H_2O + 3SO_4^{2-} + 14H_2O$$

(5 markah)

(ii) Dengan menggunakan jawapan S3(c)(i), hitungkan jumlah enapcemar (dalam g/hari) jika kadaralir adalah 4000 m^3/hari.

(2 markah)

(d) Sebuah penjernih bulat digunakan untuk menyingkirkan pepejal terampai di dalam perawatan air. Rekabentukkan sebuah penjernih bulat dengan menggunakan kriteria berikut:

-kadaralir rekabentuk	= 1000 m^3/hari
- masa tahanan	= 3 jam
- nisbah diameter terhadap kedalaman	= 1.5 : 1
- panjang alurlimpah	= 10 m

Berikan komen berdasarkan jawapan anda bagi perkara berikut:

- kadaralir limpah permukaan	= 20- 35 m^3/hari/m^2
- kadaralir limpah alur limpah	= 150 – 300 m^3 /hari/m

(9 markah)

S4 (a) Namakan **dua (2)** proses di bawah setiap unit rawatan yang berikut dan bincangkan fungsi setiap proses:

(i) Pra-rawatan
(ii) Rawatan Tertiar

(6 markah)

(b) Bezakan di antara sistem pertumbuhan terlekat dan pertumbuhan terampai rawatan biologi air sisa dan beri contoh untuk setiap sistem.

(2 markah)

(c) Data berikut telah dilaporkan pada operasi tangki enap primer dan sistem enapcemar teraktif di Loji Rawatan Air Sisa:

Tangki Enap Primer

	Infuen	Kecekapan Penyingkiran
BOD	150mg/L	35%
Pepejal Terampai	275 mg/L	60%

Sistem Enap Cemar Teraktif
-dengan kecekapan penyingkiran 90% BOD dan Pepejal Terampai beroperasi seperti berikut:

Kadar Aliran	: 0.08m^3/s
Dimensi Tangki Pengudaraan	: 7.5 lebar, 30m panjang, 4m dalam (2 tangki beroperasi secara siri)
Pepejal Terampai Meruap Likur Tercampur	: 3000 mg/L
Aliran Kembali	: 0.03m^3/s
Kepekatan Sisa Enap Cemar	: 6000 mg/L
Aliran Sisa Enap Cemar	: 0.001m^3/s

Kira:

(i) Masa tahanan hidraulik

(ii) Nisbah makanan: mikrorganisma

(iii) Min masa mastautin sel

(11 markah)

(c) Sebuah kebuk kersik direka untuk merawat air sisa (22°C) dengan kadar limpahan $4752 m^3/m^2.d$. Anggapkan Hukum Stokes terpakai, kirakan masa yang diperlukan untuk 0.2 mm diameter zarah pasir ($\rho = 2.15$ g/cm^3) untuk terenap ke bawah tangki. Sekiranya kedalaman kebuk kersik itu adalah 0.9m, apakah panjang kebuk tersebut?.

(6 markah)

S5 (a) Definasi Perbandaran Sisa Pepejal (MSW) dan senaraikan **dua (2)** komponen-komponennya.

(2 markah)

(b) (i) Bincang kepentingan pengasingan sumber oleh MSW.

(3 markah)

(ii) Mengikut pandangan kamu, bagaimanakah pengasingan sumber MSW di rumah, sekolah-sekolah, industri dan juga premis/institusi boleh dicapai di Malaysia pada masa hadapan?

(3 markah)

(c) Komponen sampel sisa pepejal ditunjukkan di dalam **Jadual 3** di bawah:

Jadual 3

Komponen	Peratus berdasarkan berat	Kandungan lembapan (%)
Sisa taman	25	60
Sisa makanan	40	70
Plastik	6	2
Kayu	15	20
Kadboard	7	5

Kira berat kering dalam kg bagi setiap komponen berdasarkan kepada 100 kg dan keseluruhan kandungan kelembapan sampel sisa pepejal .

(6 markah)

d) Sebuah kawasan perumahan sebanyak 200,000 rumah menghasilkan 0.95 kg/orang.hari sisa pepejal perbandaran. Secara purata, setiap rumah dihuni oleh 6 penduduk.

(i) Berapa MSW yang dihasilkan dalam satu hari?

(1 markah)

(ii) Sekiranya ketumpatan sisa termampat bagi kenderaan pengangkut ialah 325 kg/m^3, tentukan berapakah isipadu sisa termampat yang perlu diambil setiap minggu.

(2 markah)

(iii) Sekiranya kenderaan pengangkut mempunyai kapasiti 50 m^3, tentukan bilangan perjalanan setiap minggu.

(2 markah)

(iv) Tentukan bilangan purata rumah di mana sisa pepejalnya akan dikutip bagi setiap perjalanan.

(1 markah)

(v) Sebuah tanah tambak digunakan untuk memuatkan sisa pepejal di bandar tersebut. Isipadu tanah tambak tersebut mempunyai isipadu 11.50×10^6 m^3, dengan kepekatan sisa termampat adalah 490 kg/m^3, dan nisbah isipadu timbusan kepada isi termampat ialah 1.9. Sekiranya 67% daripada tanah tambak telah digunakan, kira jangka hayat yang tinggal bagi tanah tambak (dalam tahun)?

(5 markah)

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List of formula

(a) $\frac{F}{M} = \frac{QS_o}{VX}$

(b)

Mean cell residence time, $\theta_c = \frac{MLVSS\ x\ V}{(Q_w X_r) + (Q - Q_w)(X_e)}$

(c) SS in the effluent = $Q_{effluent}$ x Concentration SS

(d) $v_s = \frac{g(\rho_s - \rho)d^2}{18\mu}$

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TABLE A-1
Physical properties of water at 1 atm

Temperature (°C)	Density, ρ (kg/m^3)	Specific weight, γ (kN/m^3)	Dynamic viscosity, μ (m(Pa · s))*	Kinematic viscosity, ν (μ(m^2/s))*
0	999.842	9.805	1.787	1.787
3.98	1,000.000	9.807	1.567	1.567
5	999.967	9.807	1.519	1.519
10	999.703	9.804	1.307	1.307
12	999.500	9.802	1.235	1.236
15	999.103	9.798	1.139	1.140
17	998.778	9.795	1.081	1.082
18	998.599	9.793	1.053	1.054
19	998.408	9.791	1.027	1.029
20	998.207	9.789	1.002	1.004
21	997.996	9.787	0.998	1.000
22	997.774	9.785	0.995	0.957
23	997.542	9.783	0.932	0.934
24	997.300	9.781	0.911	0.913
25	997.048	9.778	0.890	0.893
26	996.787	9.775	0.870	0.873
27	996.516	9.773	0.851	0.854
28	996.236	9.770	0.833	0.836
29	995.948	9.767	0.815	0.818
30	995.650	9.764	0.798	0.801
35	994.035	9.749	0.719	0.723
40	992.219	9.731	0.653	0.658
45	990.216	9.711	0.596	0.602
50	988.039	9.690	0.547	0.554
60	983.202	9.642	0.466	0.474
70	977.773	9.589	0.404	0.413
80	971.801	9.530	0.355	0.365
90	965.323	9.467	0.315	0.326
100	958.366	9.399	0.282	0.294

*Pa · s = (mPa · s) × 10^{-3}
*m^2/s = (μm^2/s) × 10^{-6}

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