# UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

## EAP 215/3 – Water Supply and Water Treatment Engineering

[*Kejuruteraan Bekalan dan Olahan Air*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **TEN (10)** pages of printed material including 1 appendix before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat yang bercetak termasuk 1 lampiran sebelum anda memulakan peperiksaan ini.*]

**Instructions** : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan]*.

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 page.
[*Semua soalan **MESTILAH** dijawab pada muka surat baru*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) With the aid of a sketch diagram, briefly describe the components involved in hydrological cycle.

[5 marks]

(b) You are appointed as a consultant engineer for the proposal of an intake site to abstract water from a river for public water supply system. In carrying out the proposal of an intake site, suggest **FIVE (5)** criteria for your consideration.

[5 marks]

(c) **Table 1** shows historical population data from a particular district in Malaysia. Calculate the projected population in rural and urban areas using Arithmetic, Geometric and Incremental Increase Methods in year 2050.

**Table 1**

| Year | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|
| Total Population | 50,000 | 60,000 | 80,000 | 110,000 |
| Percentage of Rural Population | 40 | 35 | 35 | 30 |

[10 marks]

2. (a) Sketch a diagram for coagulation process using mechanical rapid mixing system. With the aid of the sketch diagram, suggest **FOUR (4)** criteria for the optimum designing and operation of mechanical rapid mixing.

[4 marks]

(b) With the aid of a sketch diagram briefly describe recycled flow dissolved air flotation.

[4 marks]

(c) A flocculator is designed to treat 70,000 $m^3$/day is 30m long, 12m wide and 4.5m deep. It is equipped with 0.3m paddles supported parallel to and moved by 4 horizontal shafts which rotate at a speed of 2.5 rpm. The centre line of the paddle is 1.7m from the shaft, which is at mid depth of the tank. Two paddles are mounted on each shaft, one opposite the other. Assuming that the mean velocity of the water is approximately ¼ the velocity of the paddles, that the drag coefficient of the paddles is 1.8 and that the dynamic viscosity of water at $10^0$C is $1.31 \times 10^{-3}$ Ns/$m^2$.

Calculate the following :

(i) The velocity differential between the paddle and the water

[3 marks]

(ii) The useful power input

[3 marks]

(iii) The detention time

[3 marks]

(iv) The velocity gradient.

[3 marks]

3. (a) Briefly describe the following terms with respect to potable water treatment:

(i) Sedimentation
(ii) Clarification

[4 marks]

(b) The use of slow sand filter in drinking water treatment can be traced back to 1892 in Hamburg where its importance was realised. Briefly describe the advantages of slow sand filter.

[6 marks]

(c) A treatment plant has a capacity of 6 million litres per day with daily operation of three (3) shifts. For each shift, 50 kg of alum is mixed with water until the alum strength of 10% is achieved. If a jar test carried out in the laboratory shows that the optimum alum dosage was made based on 20ml alum solution mixed with 1500ml of raw water, calculate the weight of the initial alum that was originally used to make a volume of 1000ml of alum solution. Calculate also the volume of container required to prepare alum solution for the duration of one (1) shift.

[10 marks]

4. (a) Chlorine is widely used as disinfectant agent for potable water. Suggest the advantages of chlorine.

[6 marks]

(b) If you are working as a water treatment plant engineer and the water naturally contains ammonia, suggest and explain the chlorination process that should be undertaken.

[6 marks]

(c) With the aid of a sketch diagram, discuss the advantages of a gravity system with respect to public water supply distribution system.

[8 marks]

5. (a) Non-revenue water (NRW) is currently an important issue that needs to be solved. If you are employed as a waterworks engineer in an area with an NRW of 40%, suggest strategy to be developed in order to reduce the percentage of NRW.

[10 marks]

(b) **Figure 1** shows a water reticulation system. Estimate the flow rate in each pipeline using Hardy's cross Method and Hazen-William Formula up to two iterations. Assume an initial flow rate of 100 $m^3$/hour from point A to B. The Length of pipes are AB=2000m, BC=700m, CD=2200m and AD=800m. The diameters of pipe AB= 300mm, BC=250mm, CD=250mm and AD=300mm. The Hazen William coefficient for each pipe is 100.

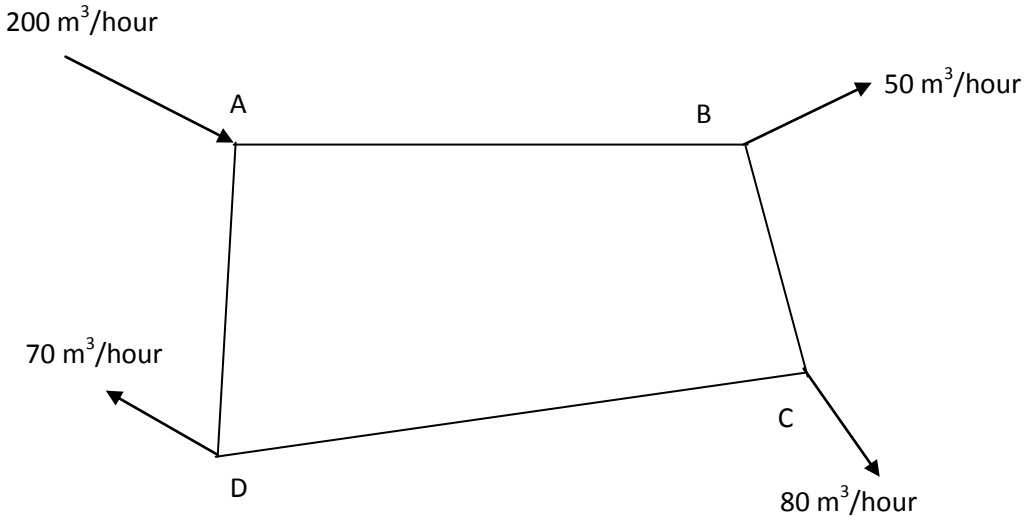



**FIGURE 1**

[10 marks]

6. (a) Describe the **FOUR (4)** parameters water of quality practiced in Malaysia.

[8 marks]

(b) For the following contaminants, state the source, health effects and standards requirements for water quality;

(i) Turbidity
(ii) Total coliforms
(iii) Arsenic
(iv) Cadmium

(v) Chromium
(vi) Chlorine
(vii) Cryptosporidium
(viii) Giardia lamblia

[8 marks]

(c) Water quality data were used to determine the water quality status wheather in clean, slightly polluted or polluted category and to classify the rivers based on the **INTERIM NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA .**

(i) Discuss the Classes in detail.
(ii) With reference to Sg Kerian at Ampang Jajar, what would be the class of water quality index?

[4 marks]

1. (a) *Dengan bantuan rajah yang dilakar, huraikan dengan ringkas komponen-komponen yang terdapat dalam kitaran hidrologi.*

*[5 markah]*

(b) *Anda dilantik sebagai seorang jurutera perunding untuk memberi cadangan tapak takat pengambilan air daripada sebatang sungai bagi sistem bekalan air awam. Dalam memberikan cadangan takat pengambilan air tersebut, syorkan **LIMA (5)** kriteria yang perlu dipertimbangkan.*

*[5 markah]*

(c) ***Jadual 1** menunjukkan data penduduk yang lepas dari daerah tertentu di Malaysia. Hitung jangkaan penduduk bagi kawasan bandar dan luar bandar menggunakan kaedah Aritmatik, Geometrik dan Pertambahan Tokokan dalam tahun 2050.*

***Jadual 1***

| *Tahun* | *1980* | *1990* | *2000* | *2010* |
|---|---|---|---|---|
| *Jumlah Penduduk* | *50,000* | *60,000* | *80,000* | *110,000* |
| *Peratus Penduduk Luar Bandar* | *40* | *35* | *35* | *30* |

*[10 markah]*

2. (a) *Lakarkan rajah untuk proses pengentalan menggunakan sistem pencampur deras mekanikal. Dengan bantuan rajah yang dilakar, syorkan **EMPAT (4)** kriteria untuk rekabentuk dan operasi pencampur deras mekanikal.*

*[4 markah]*

(b) *Dengan bantuan rajah yang dilakar, huraikan dengan ringkas pengapungan udara terlarut aliran kitar semula.*

*[4 markah]*

(c) *Tangki pemberbukuan direka bentuk untuk olahan 70,000 $m^3$/hari mempunyai 30m panjang, 12m lebar dan 4.5m dalam. Tangki dipasang dengan 0.3m penganyuh disokong pada keadaan selari diantaranya dan digerakkan oleh 4 aci mendatar yang berputar pada kelajuan 2.5 pusingan seminit. Pusat penganyuh terletak 1.7m daripada pusat aci yang berada pada pertengahan kedalaman tangki. Dua penganyuh dipasang pada setiap aci, setiap satu pada keadaan berlawanan. Anggap halaju min air lebih kurang ¼ dari halaju penganyuh, pekali seret penganyuh ialah dan kelikatan dinamik air pada 1.8 $10^0$C ialah $1.31x10^{-3}$ Ns/$m^2$.*

*Hitung:*

*(i) Perbezaan halaju diantara penganyuh dan air*

*[3 markah]*

*(ii) Kuasa masukan yang digunakan*

*[3 markah]*

*(iii) Masa tahanan*

*[3 markah]*

*(iv) Kecerunan halaju.*

*[3 markah]*

3. *(a) Huraikan dengan ringkas terma-terma berikut berdasarkan olahan air minuman:*

*(i) Enapan*
*(ii) Penjernihan*

*[4 markah]*

*(b) Penggunaan penapis pasir perlahan dalam olahan air minuman boleh dijejak kembali pada tahun 1892 di Hamburg dimana kepentinganya diketahui. Huraikan dengan ringkas mengenai kebaikan-kebaikan penapis pasir perlahan.*

*[6 markah]*

*(c) Loji olahan air mempunyai kapasiti 6 juta liter sehari dengan operasi harian sebanyak 3 shif. Untuk setiap shif, 50kg tawas dicampurkan dengan air sehingga kekuatan tawas sebanyak 10% diperolehi. Jika ujian baling dijalankan dimakmal menunjukan dos tawas optimum dibuat berdasarkan 20ml larutan tawas dicampurkan dengan 1500ml air mentah, hitung berat awal tawas yang asalnya digunakan untuk membuat isipadu 1000ml larutan tawas. Hitung juga isipadu bekas yang diperlukan untuk menyediakan larutan tawas bagi tempoh satu (1) shif.*

*[10 markah]*

4. *(a) Klorin digunakan dengan meluas sebagai agen pembunuh kuman untuk air minuman. Syorkan kebaikan-kebaikan klorin.*

*[6 markah]*

*(b) Jika anda bekerja sebagai jurutera loji olahan air dan air secara semula jadi mempunyai ammonia, syorkan dan jelaskan proses pengklorinan yang patut dilakukan.*

*[6 markah]*

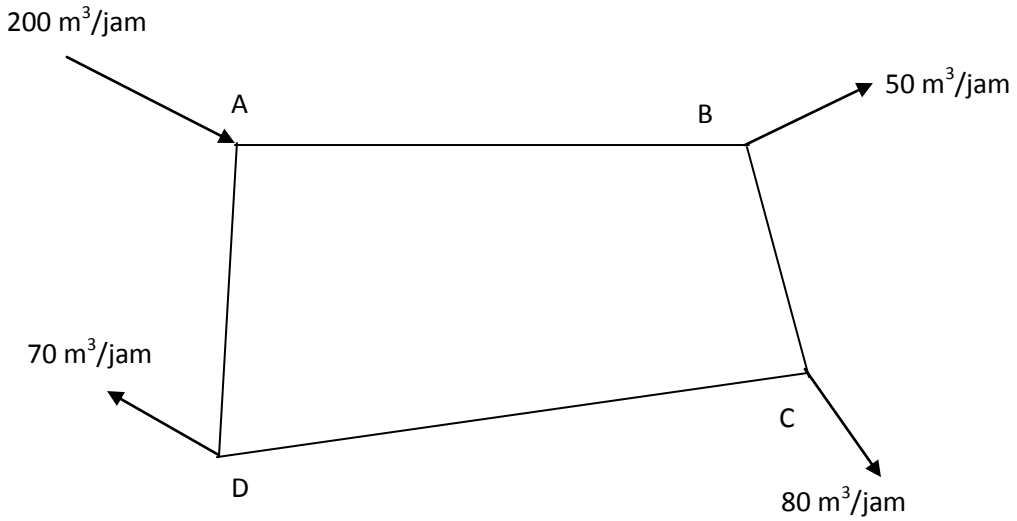
*(c) Dengan bantuan rajah yang dilakar, bincangkan kebaikan-kebaikan sistem graviti berdasarkan sistem agihan bekalan air awam.*

*[8 markah]*

5. (a) *Air tak berhasil menjadi isu penting masa kini yang perlu diselesaikan. Jika anda bekerja sebagai jurutera kerja air di kawasan yang mempunyai air tak berhasil sebanyak 40%, syorkan strategi yang perlu dibangunkan untuk mengurangkan peratus air tak berhasil.*

*[10 markah]*

(b) ***Rajah 1*** *menunjukkan sistem retikulasi air. Anggarkan kadar alir dalam setiap cabang paip menggunakan Kaedah Hardy's Cross dan Rumusan Hazen-William sehingga dua iterasi. Andaikan kadar alir awal sebanyak 100 $m^3$/jam dari titik A ke B. Panjang paip untuk AB=2000m, BC=700m, CD=2200m dan AD=800m. Garispusat paip adalah AB= 300mm, BC=250mm, CD=250mm dan AD=300mm. Pekali Hazen William untuk setiap paip ialah 100.*




***RAJAH 1***

*[10 markah]*

6. (a) *Terangkan **EMPAT (4)** agen kualiti air yang diamalkan di Malaysia.*

*[8 markah]*

(b) *Untuk pencemar-pencemar berikut, nyatakan sumber, kesan kesihatan dan keperluan standard untuk kualiti air, iaitu*

*(i) Kekeruhan*
*(ii) Jumlah Koliform*
*(iii) Arsenik*
*(iv) Kadmium*
*(v) Kromium*

*(vi)* *Klorin*
*(vii)* *Cryptosporidium*
*(viii)* *Giardia lamblia*

*[8markah]*

*(c)* *Data kualiti air digunakan untuk menetapkan statu kualiti air samada ianya kategori bersih, sedikit tercemar atau tercemar and untuk mengelaskan sungai berdasarkan* ***Standard Kualiti Air Interim Untuk Malaysia****.*

*(i)* *Bincangkan dengan terperinci Kelas-kelas tersebut.*
*(ii)* *Dengan merujuk kepada Sg Kerian di Ampang Jajar, apakah kelas indeks kualiti airnya?*

*[4 markah]*

**APPENDIX/LAMPIRAN**

Equations related to water supply:

Persamaan berkaitan bekalan air:

$$P_n = P_i + nI$$

$$P_n = P_i\left(1+\frac{i}{100}\right)^n$$

$$P_n = P_i + n(+m)$$

$$P_n = P_i\left(1+\frac{(1-k}{100}\right)^n$$

$$G = \left(\frac{P}{\mu\forall}\right)^{1/2}$$

$$P = \frac{1}{2}C_d\rho A\vee^3$$

$$P = \rho Qgh$$

$$h_L = KQ^2$$

$$\frac{d_1}{d_2} = \frac{1}{2}\left[(-8F^2)^{1/2} - 1\right]$$

$$F = \frac{V_1}{(gd_1)^{1/2}}$$

$$\mathrm{Re} = \frac{\rho v d}{\mu}$$

$$\Delta H = [(v_1^2 + 5v_2^2 + 4v_3^2)/2g] + \mathrm{normal\,channel\,friction}$$

$$h = \frac{nv_1^2 + (n-1)v_2^2}{2g}$$

$$v_s = \frac{gd^2(\rho_s - \rho_w)}{18\mu}$$

$$t = \frac{2\pi H}{Q}\int_{R1}^{R2} rdr = \frac{\pi(R_2^2 - R_1^2)H}{Q}$$

$$V_s = \frac{Q}{A}$$

$$D = V_s t$$

$$L = \frac{0.2Q}{HV_s}$$

$$H = \frac{1128\times10^9}{d^{4.87}}\left[\frac{Q}{100}\right]^{1.85}$$

$$\Delta = -\frac{\Sigma H}{N\sum\frac{H}{Q_a}}$$

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