UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2003/2004 Academic Session
Peperiksaan Semester Pertama
Sidang Akademik 2003/2004

September / October 2003

EAV 581/4 – Water Supply Engineering
EAV 581/4 – Kejuruteraan Bekalan Air

Duration: 3 hours
Masa : 3 jam

Instructions to candidates:
Arahan kepada calon:

1. Ensure that this paper contains **EIGHT (8)** printed pages.
   *Sila pastikan kertas peperiksaan ini mengandungi **LAPAN** (8) muka surat bercetak sebelum anda memulakan peperiksaan ini.*

2. This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIRST FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5).**
   *Kertas ini mengandungi **ENAM** (6) soalan. Jawab **LIMA** (5) soalan sahaja. Markah hanya akan dikira bagi **LIMA** (5) jawapan **PERTAMA** yang dimasukkan di dalam buku mengikut susunan dan bukannya **LIMA** (5) jawapan terbaik.*

3. All questions carry equal marks.
   Tiap-tiap soalan mempunyai markah yang sama.

4. Questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.
   Soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.

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

6. Each question **MUST BE** answered on new page.
   *Semua jawapan **MESTILAH** dimulakan pada muka surat yang baru.*

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1. (a) Discuss at least **THREE (3)** laws available in Malaysia to protect the sources of water and pollution control.

(6 marks)

*(a) Bincang sekurang kurangnya **TIGA (3)** undang-undang sedia ada di Malaysia untuk melindungi sumber-sumber air dan pengawalan pencemaran.*

(6 markah)

(b) Write short notes on the problems of turbidity and suspended solids in the water treatment process.

(4 marks)

(b) Berikan penerangan ringkas mengenai kepentingan masalah kekeruhan dan pepejal terampai dalam proses rawatan air.

(4 markah)

(c) i. The result of water analysis from a river in an isolated area in Perak is shown below. Build up a bar chart of the ions expressed as mg/L $CaCO_3$.

ii. From the bar chart, determine its total hardness, carbonate hardness and non carbonate hardnesses expressed as mg/L $CaCO_3$.

River Water Analysis(mg/L)
Ca^{2+} = 120 , K^+ = 5, Mg^{2+} = 40
SO_4^{2-} = 45, HCO_3^- = 318.0, NH_4^- = 1.5, Cl^-= 1.2

Relative Atomic Weights
Ca= 40, Mg= 24, K= 39
C=12, S=32, O=16, N=14,
Cl= 35.5, H=1.0

(10 marks)

(c) i. Keputusan analisis air dari sebatang sungai dari kawasan pendalaman diberikan dibawah. Bina carta palang ion-ion itu dalam sebutan mg/L $CaCO_3$.

ii. Dari carta palang dalam c(i), dapatkan keliatan jumlah, keliatan karbonat dan keliatan bukan karbonat dalam sebutan $CaCO_3$.

Analisis Air Sungai (mg/L)
Ca^{2+} = 120 , K^+ = 5, Mg^{2+} = 40
SO_4^{2-} = 45, HCO_3^- = 318.0, NH_4^- = 1.5, Cl^-= 1.2

Berat Atom Relatif
Ca= 40, Mg= 24, K= 39
C=12, S=32, O=16, N=14,
Cl= 35.5, H=1.0

(10 markah)

2. Electrodialysis process is used to prepare drinking water from brackish water with capacity of 24000 m^3/day. The process reduces the salt concentration from 1500 mg/L to 300 mg/L with 50% conversion and the current efficiency of the supplied power is 80%. A current density of 5 m A/cm^2 is used as direct current to retain and hold the salt in the concentrated brine chamber. A stack of 300 cell pairs each has 0.5 m^2 with total area of 150 m^2 been used. Given the total of all cell pairs by Faraday's law.

$$A_m = \frac{ZFQ\Delta C}{i\varepsilon}$$

where F = Faraday's Constant, 9520 Amp/equiv.
Z = Electrochemical Valence for NaCl = 1
Q = Volumetric Flow Rate, m^3/s
ΔC = Concentration gradient between feed and product, mol / m^3
i = Current Density Amp/m^2 of cell pair
ε = Current Efficiency

Estimate membrane area and electrical energy required for the specified electrodialysis process. Power is I.E where E can be assumed about 1v.

(20 marks)

Proses elektrodialisis digunakan untuk menyediakan air minuman dari air laut dengan kapasiti 2400 m^3/hari. Proses ini mengurangkan kepekatan garam dari 1500 mg/L ke 300 mg/L dengan 50% penukaran dan kecekapan arus kuasa dibekal adalah 80%. Ketumpatan arus 5m A/cm^2 digunakan sebagai arus terus untuk menahan garam di kebuk garam pekat. Suatu turus 300 pasangan sel setiap satu dengan keluasan jumlah 150 m^2 digunakan. Diberi jumlah keseluruhan berpasang secara hokum Faraday.

$$A_m = \frac{ZFQ\Delta C}{i\varepsilon}$$

di mana F = Konstan Faraday, 9520 Amp/setara
Z = Valensi elektrokimia NaC1 = 1
Q = Kadaralir m^3/s
ΔC = Cerun kepekatan di antara suapan dan produk, mol/m^3
i = Ketumpatan arus Amp/m^2 pasangan sel
ε = Kecekapan arus

Anggarkan keluasan mambran dan tenaga elektrik untuk proses elektrodialisis tersebut. Kuasa adalah I.E. di mana E boleh dianggap sebagai 1v.

(20 markah)

3. (a) Water demand for trade and industry may be large or small irrespective of area or population served. Discuss briefly four classes of trade and industrial water demand.

(4 marks)

(a) Permintaan air untuk perdagangan dan industri mungkin tinggi atau rendah tanpa mengira kawasan atau bilangan penduduk yang dibekalkan. Bincangkan dengan ringkas empat kelas permintaan air untuk perdagangan dan industri.

(4 markah)

(b) In practice the total losses for 'unaccounted for water' or sometime called non-revenue water may vary from 5% to 55% or more of the total water supply. Discuss briefly on three elements that contribute to total loss.

(6 marks)

(b) Pada amalan jumlah kehilangan untuk 'air tanpa akaun' atau kadang kala dipanggil air tak berhasil mungkin berubah dari 5% hingga 55% atau lebih daripada jumlah air yang dibekalkan. Bincangkan dengan ringkas terhadap tiga unsur yang menyumbang kepada jumlah kehilangan.

(6 markah)

(c) Table 1.0 shows the total population of each decade for a proposed area to have a public water supply. The local authority informs you that 80% of the urban and 60% of the rural population in 2001 had received public water supply.

The local authority invites you to design a water supply scheme for the year 2031 where 100% of the urban and 80% of the rural populations will get a public water supply. Using a geometric method of population projection, calculate the capacity of a new treatment plant to be constructed to cater the population up to the year 2031. Assume water demand is constant with 250 and 230 litres per capita per day for the urban and rural areas respectively.

Table 1.0

Year	1961	1971	1981	1991
Population	50,000	66,000	70,000	82,000
Percentage of population in the urban	20	25	30	35

(10 marks)

(c) Jadual 1.0 menunjukkan jumlah penduduk setiap dekad untuk kawasan yang dicadangkan untuk menerima bekalan air awam. Pihak berkuasa tempatan memberitahu anda bahawa 80% daripada penduduk bandar dan 60% daripada penduduk luar bandar menikmati bekalan air bersih pada tahun 2001.

Pihak berkuasa tempatan menjemput anda untuk merekabentuk sekim bekalan air untuk tahun 2031 di mana sebanyak 100% penduduk bandar dan 80% penduduk luar bandar akan menikmati kemudahan air awam. Dengan menggunakan kaedah pertambahan geometrik, hitung kapasiti loji air baru yang perlu dibina untuk menampung keperluan penduduk pada tahun 2031. Anggap permintaan air malar masing-masing pada 250 dan 230 liter per kapita per hari untuk penduduk bandar dan luar bandar.

Jadual 1.0

Tahun	1961	1971	1981	1991
Penduduk	50,000	66,000	70,000	82,000
Peratus pertambahan penduduk dalam bandar	20	25	30	35

(10 markah)

4. (a) Explain briefly on the definition of Camp Number and its significant in water treatment process.

(3 marks)

(a) Jelaskan mengenai takrif "Nombor Camp" dan huraikan mengenai signifikan "Nombor Camp" dalam proses olahan air.

(3 markah)

(b) Discuss the effect of temperature on the flocculation, horizontal flow sedimentation and up-flow clarifier.

(7 marks)

(b) Bicangkan mengenai kesan suhu terhadap proses pembukuan, tangki enapan aliran mendatar dan penjernih aliran ke atas (penjernih lapisan/selimut enapcemar).

(7 markah)

(c) For a mechanically tapered flocculation process, three flocculation tanks require to be constructed in series. The designed velocity gradient for the first, second and third tanks are 80 s^{-1}, 50 s^{-1}, 20 s^{-1} respectively. The flow rate for each tank is 2 million litres per day and the water temperature is 20^0C (dynamic viscosity = $1.005x10^{-3}$kg/ms and density of water = 998.23 kg/m^3). Retention time in each tank is 3 minutes. Calculate the dimension of each flocculation tank and suggest the appropriate dimension. Calculate the input power requires to rotate the blade in each tank.

(10 marks)

(c) Untuk proses pembukuan tirus (tapered flocculation) mekanikal, 3 buah tangki pembukuan perlu dibina dalam siri. Rekabentuk cerun halaju untuk tangki pertama ialah 80 s^{-1}, tangki kedua ialah 50 s^{-1}, dan tangki ketiga ialah 20 s^{-1}. Kadar alir air melalui ketiga-tiga tangki ialah 2 juta liter sehari dan suhu air ialah 20^0C (kelikatan dinamik = $1.005x10^{-3}$kg/ms dan ketumpatan air = 998.23 kg/m^3). Masa tahanan di dalam setiap tangki ialah 3 minit. Hitung isipadu untuk setiap tangki air pembukuan dan sila syorkan dimensi yang sesuai. Hitung juga kuasa yang dikenakan untuk memutar bilah-bilah di dalam setiap tangki.

(10 markah)

5. (a) Dissolved air flotation process is gaining popularity in its application for water treatment process in this country. Briefly explain the advantages of dissolved air flotation process over the conventional method.

(5 marks)

(a) Proses pengapungan udara terlarut menjadi masyur dalam penggunaannya untuk proses olahan air di negeri ini. Jelaskan dengan ringkas mengenai kebaikan proses pengapungan udara terlarut terhadap proses konvensional.

(5 markah)

(b) In Malaysia most of water authorities are phasing out the use of asbestos cement pipes for the distribution system. Briefly describe the disadvantages of asbestos cement pipes.

(5 marks)

(b) Di Malaysia kebanyakan pihak berkuasa air telah memansuhkan penggunaan paip simen asbestos dalam sistem agihan. Jelaskan dengan ringkas mengenai kelemahan paip simen asbestos.

(5 markah)

(c) Two sets of jar test are carried out in the laboratory for raw water with a turbidity of 20 NTU and alkalinity concentration HCO_3^- of 50 mg/L as $CaCO_3$. The test indicates that the optimum pH and alum dose of 6.5 and 15 mg/L respectively. Calculate the theoretical alkalinity $CaCO_3$ that would be consumed at the optimal dose. Chemical reaction involves when alum is added to the raw water is shown in the following equation:

$$Al_2(SO_4)_3.14H_2O + 6HCO_3^- \rightarrow 2Al(OH)_3 + 6CO_2 + 14H_2O + 3SO_4^{2-}$$

Molecular weight of the related elements as shown below:

Oxygen = 16, Sulphur = 32, Aluminium = 27, Hydrogen =1, Carbon = 12.

(10 marks)

(c) Dua set ujian jar dilakukan di makmal untuk air mentah dengan kekeruhan 20 NTU dan kepekatan kealkalian HCO_3^- 50 mg/L sebagai $CaCO_3$. Ujian menunjukkan takat optimum untuk pH dan dos alum masing-masing 6.5 dan 15 mg/L. Hitung kealkalian teori $CaCO_3$ yang akan digunakan pada dos optimum. Tindak balas kimia berlaku semasa tawas dicampur kepada air mentah seperti persamaan berikut:

$$Al_2(SO_4)_3.14H_2O + 6HCO_3^- \rightarrow 2Al(OH)_3 + 6CO_2 + 14H_2O + 3SO_4^{2-}$$

Berat molikul untuk element berkaitan ditunjukkan seperti berikut:

Oksigen = 16, Sulfur = 32, Aluminium = 27, Hidrogen =1, Karbon = 12.

(10 markah)

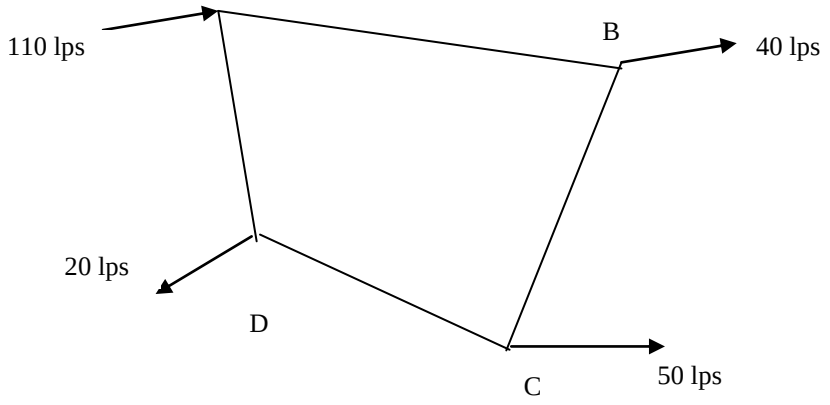
6. (a) Figure 1.0 shows a reticulation system in a housing estate. Estimate the flow rate in each pipeline using Hardy-Cross Method and Hazen-William formula. You are expected to estimate the flow rate up to the second correction only. Use an initial flow rate of 70 litres per second (lps) from point A to B. The lengths and diameters of pipes are as shown in Table 2.0.

Table 2.0

Pipes	Length (m)	Diameter (mm)
AB	1000	250
BC	1200	250
CD	800	150
AD	700	150

Use Hazen-William coefficient of 100.

Figure 1.0



(10 marks)

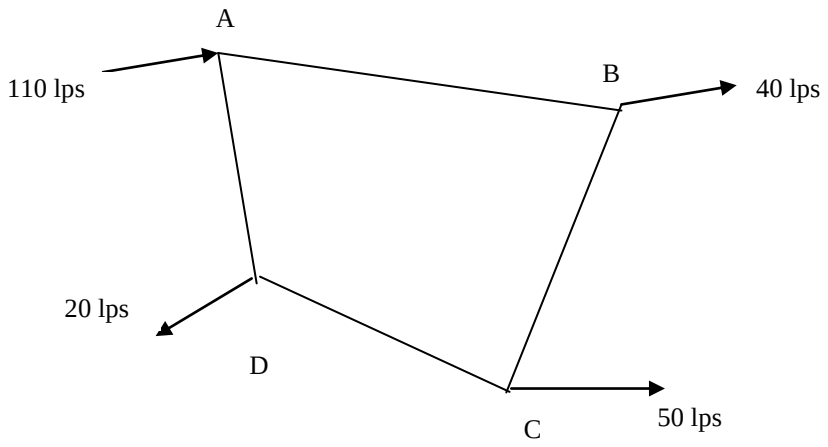
(a) Rajah 1.0 menunjukkan sistem retikulasi untuk sebuah kawasan perumahan. Anggarkan kadar alir dalam setiap paip menggunakan Kaedah Hardy-Cross dan formula Hazen-William. Anda dikehendaki membuat anggaran kadar alir sehingga dua pembetulan sahaja. Gunakan kadar alir awal sebanyak 70 liter per saat (lps) dari titik A ke B. panjang dan garispusat paip ditunjukkan dalam Jadual 2.0

Jadual 2.0

Paip	Panjang (m)	Garispusat (mm)
AB	1000	250
BC	1200	250
CD	800	150
AD	700	150

Gunakan nilai 100 sebagai pekali Hazen-William.

Rajah 1.0



(10 markah)

(b) The characteristic of Chini Lake, Pahang Darul Makmur
Volume : 700,000 m^3
Inflow = outflow = 12000 m^3/d
Mean Depth : 2.5
Temperature : 20^oC
The Chini natural lake receives the input of a pollutant from several sources. A agricultural farm discharge of 100 kg/d, atmospheric fallout is counting $0.5g/d/m^2$ and flow from stream that has a concentration of 10mg/L. If the pollutant decays at the rate of 0.5/d at 20^oC ($\theta = 1.05$)
Please state any additional assumptions you made, and show all work.
(Note : $k = \theta^{tn-t20}$; a = Q + kV; c=W/a)

i. Compute the assimilation factor
ii. Determine the steady-state concentration
iii. Calculate the mass per time foe each term in the mass balance and display your result on a plot.

(7 marks)

(b) To study the photodegration of aqueous bromine, we dissolved a small quantity of liquid bromine in water, placed it in a clear jar, and exposed it to sunlight. The following data were obtained:

t (min)	**0**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**
C (ppm)	10	8.4	6.5	4.4	2.3	1.6	1.3	1.2	1.1	1.1

Determine the estimate decay rate for reaction rate.

(3 marks)

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