UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	:	WATER SUPPLY DESIGN
SUBJECT CODE	:	BFA 4023
COURSE	:	4 BFF
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER THREE (3) QUESTIONS ONLY

THIS PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 The following data are available for a community's proposed domestic water supply: design period = 25 years; present population = 2500 people; population growth rate = 4%; average domestic water consumption = 0.32m^3 per person per day.

You are required to design the following water treatment plant components for the scheme:

(a) Two (2) similar pre-sedimentation basins, rectangular in shape, each with a detention time of 3 hours, basin depth of 0.3m, and maximum overflow rate of 200 m^3/day of average flow per metre length of weir.

(5 marks)

(b) Six (6) circular tray aerators based on the requirement of 1.0m^2 tray surface area per 0.3m^3/minute of average flow.

(5 marks)

(c) A rectangular cascade aerator based on the requirement of 0.2m^2 surface area per litre/second of average flow.

(5 marks)

(d) A flocculation basin consisting of two (2) tanks assuming $G.t$ = 3.5 x 10^4 and velocity gradient, G = 25 per second based on average flow conditions. Each tank is 3m long by 3m deep with 20 minutes retention time.

(5marks)

Q2 Flow records shown in **Table Q2** represent the lowest average discharges for seven consecutive days for each year from 1961 to 1982 for a river upon which a community water supply depends.

Table Q2

Year	Lowest average discharge, cubic feet per second
1961	19.6
1962	28.6
1963	18.1
1964	34.3
1965	29.3
1966	35.7
1967	35.0
1968	27.0
1969	35.0
1970	36.9
1971	90.3
1972	50.6
1973	35.3
1974	59.4
1975	26.3
1976	30.1
1977	29.4
1978	29.7
1979	30.4
1980	49.6
1981	36.6
1982	59.1

(a) Arrange the flows in order of severity by designation of the serial number M from 1 to n. Hence, calculate the flow ranking using the formula $M/(n + 1)$. Plot the flow against the ranking on the probability paper provided to determine the minimum flow for a return period of 10 years.

(17 marks)

(b) What would you suggest the authority should do if the minimum flow you obtained above is less than the community's demand for potable water supply from the river source?

(3 marks)

Q3 A low turbidity river water is treated at a water treatment plant using alum coagulation. Based on the chemical equation,

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

(Atomic weights: Al=27; S=32; O=16; H=1. Equivalent weight of $CaCO_3$ is 50 g/eq)

(a) Calculate the amount of HCO_3^- alkalinity consumed as $CaCO_3$ for the optimum alum dosage (determined from Jar Test) of 25 mg/L.

(10 marks)

(b) Calculate the amount of $Al(OH)_3$ sludge produced (kg/day) for the plant flow capacity of 0.044 m^3/day.

(5 marks)

(c) Assuming the plant's influent and effluent organic matter concentrations are 8 mg/L and 3 mg/L respectively, calculate the amount of organic matter removed (kg/day) for the plant flow capacity of 0.044m^3/day.

(5 marks)

Q4 A water supply scheme is proposed for a community. Water demand characteristics at full plant capacity are as follows:

Design population = 10,000 people
Domestic demand (average) = 0.32m^3 per day per person
Industrial demand (average) = 30% of domestic demand
Agriculture demand (average) =50% of domestic demand
Fire fighting demand is based on 1500 GPM (8175 m^3/d) for 4hr duration.

You are to provide a preliminary design for the scheme that should meet the following requirements:

1. Low lift pumping (at intake works)
2. High lift pumping (from clear water well to consumers)
3. Treated water is pumped (for 8 hours daily) directly from the plant to the consumers.
4. Storage requirements to equalize demand plus storage for fire fighting

Use the following assumptions (rules of thumb):

1. Maximum day demand=1.5 x Average daily demand
2. Peak hourly demand=2.0 x Average daily demand
3. Storage to equalize demand (based on 8h pumping) = 80% of maximum day usage.

(20 marks)

S1 Berikut ialah data cadangan bekalan air domestik satu komuniti: jangkamasa rekabentuk = 25 tahun; bilangan penduduk sekarang = 2500; kadar pertumbuhan penduduk = 4%; kadar pengunaan air domestik=0.32m^3 seorang sehari.

Anda dikehendaki merekabentuk komponen-komponen loji rawatan air bekalan seperti berikut:

(a) Dua tangki pra-enapan segiempat bujur dengan setiap tangki mempunyai masa tahanan 3 jam, kedalaman 0.3m, dan kadar alir limpah maksimum 200 m^3/hari pada keadaan aliran purata.

(5 markah)

(b) Sebuah tangki pengudaraan menggunakan 6 mangkuk pengudaraan jika 1.0m^2 luas permukaan mangkuk diperlukan bagi setiap 0.3m^3/minit aliran purata.

(5 markah)

(c) Sebuah tangki pengudaraan air terjun (cascade) segiempat bujur jika 0.2m^2 luas permukaan diperlukan bagi setiap liter/saat aliran purata.

(5 markah)

(d) Dua (2) buah tangki flokulasi jika G.t = 3.5 x 10^4 dengan kecerunan halaju, G=25/saat pada keadaan aliran purata. Setiap tangki berukuran 3m panjang dan 3m lebar dengan masa tahanan 20 minit.

(5 markah)

S2 Rekod aliran seperti tersenarai **Jadual S2**, adalah aliran purata terendah berturutan selama tujuh (7) hari dari tahun 1961 hingga 1982 bagi sebuah sungai.

Jadual S2

Tahun	Aliran purata terendah, kaki^3/saat
1961	19.6
1962	28.6
1963	18.1
1964	34.3
1965	29.3
1966	35.7
1967	35.0
1968	27.0
1969	35.0
1970	36.9
1971	90.3
1972	50.6
1973	35.3
1974	59.4
1975	26.3
1976	30.1
1977	29.4
1978	29.7
1979	30.4
1980	49.6
1981	36.6
1982	59.1

(c) Aturkan aliran mengikut nombor pemberat turutan M dari 1 hingga n. Kemudian, kira tahap pemberat menggunakan formula M/(n + 1) serta plot nilai aliran melawan nilai tahap pemberat menggunakan graf kebarangkalian yang disediakan untuk menentukan aliran minimum sungai bagi tempoh kala kembali 10 tahun.

(17 markah)

(d) Cadangkan tindakan selanjutnya jika aliran minimum sungai yang anda telah perolehi di atas lebih rendah daripada keperluan bekalan air yang diperlukan komuniti.

(3 markah)

S3 Air sungai yang rendah tahap kekeruhannya dirawat di sebuah loji bekalan air menggunakan proses koagulasi alum. Berdasarkan persamaan kimia berikut,

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

(Berat atom: Al=27; S=32; O=16; H=1. Berat setara $CaCO_3$ ialah 50g/eq)

(a) Kira kealkalian HCO_3^- (mg/L) sebagai setara $CaCO_3$ terguna jika dos alum optimum ditentukan sebanyak 25 mg/L.

(10 markah)

(b) Kira kuantiti enapcemar $Al(OH)_3$ terhasil (kg/hari) pada kapasiti aliran loji 0.044 m^3/hari.

(5 markah)

(c) Dengan mengambilkira kepekatan bahan organik influen dan effluen loji masing-masing sebanyak 8 mg/L dan 3 mg/L, kira bahan organik tersingkir (kg/hari) pada kapasiti aliran loji 0.044m^3/hari.

(5 markah)

S4 Satu projek bekalan air dicadangkan untuk satu komuniti. Ciri-ciri keperluan air pada tahap kapasiti rekabentuk sepenuhnya adalah seperti berikut:

- Bilangan penduduk = 10,000 orang
- Penggunaan air domestik (purata) = 0.32m^3 sehari seorang
- Pengunaan industri (purata) = 30% daripada pengunaan domestik
- Pengunaan tanaman (purata) =50% daripada penggunaan domestik
- Pengunaan air bomba waktu kebakaran dianggarkan 1500 gelen/minit (8175 m^3/hari) selama 4 jam.

Sediakan satu rekabentuk preliminari projek tersebut bagi memenuhi keperluan berikut:

1. Kerja mengepam air mentah di titik ambilan
2. Kerja mengepam air bersih untuk penghantaran secara langsung dari loji ke pengguna berdasarkan kerja mengepam pada kadar 8 jam sehari.
3. Penyimpanan air bagi mengimbang penggunaan air serta penyimpanan untuk keperluan kebakaran.

Gunakan anggapan berikut bagi pengiraan anda:

1. Pengunaan maksimum air (harian) = 1.5 x Pengunaan air purata harian
2. Pengunaan air kemuncak = 2.0 x Pengunaan air purata harian
3. Tangki simpanan untuk pengimbangan pengunaan air berdasarkan 8 jam kerja mengepam = 80% daripada pengunaan air maksimum harian.

(20 markah)