UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

EAH 325/3 – Engineering Hydrology
[*Hidrologi Kejuruteraan*]

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

Please check that this examination paper consists of **TWELVE (12)** pages of printed material including 1 appendix you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat yang bercetak termasuk 1 lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** question.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. **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) Briefly describe **FOUR (4)** main components of hydrologic cycle.

[6 marks]

(b) The catchment with an area 1.2 ha received 40 mm of total rainfall (30 minute duration) which generate direct runoff volume of 250 m^3. Determine the effective rainfall and the hydrologic losses for the above catchment.

[4 marks]

(c) Location of four raingauges for a given catchment area is shown in **Figure 1.** Determine the mean areal rainfall using: i) Station Average (Arithmetic Average) method; ii) Thiessen Polygon method.

[10 marks]

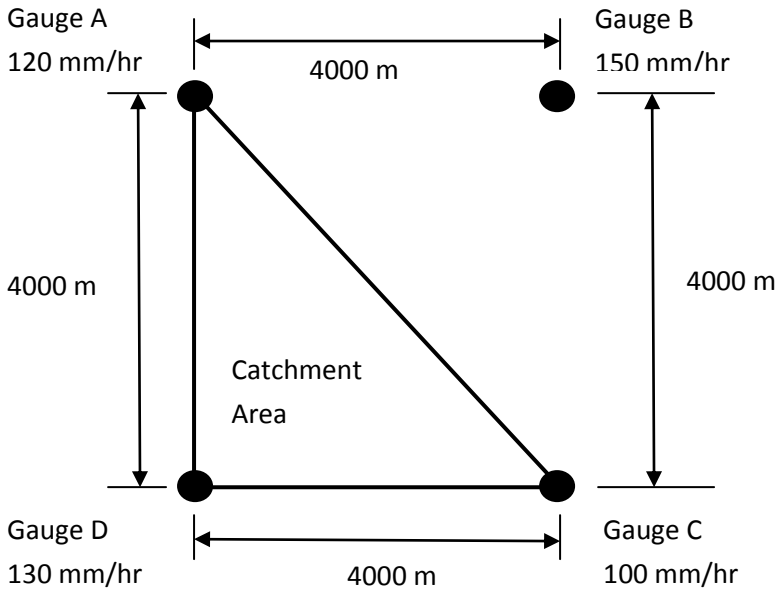


Figure 1

2. An area of 50 ha with hydrologic soil group B will be developed into housing area. The land use for pre-development (existing condition) and post-development conditions (after housing development) are as follows:

Pre-development condition (percentage of the area):

Open space – poor condition (grass cover < 50%)	30%
Open space – fair condition (grass cover 50%-75%)	30%
Open space – good condition (grass cover > 75%)	40%

Post-development condition (percentage of the area):	
Open space – good condition (grass cover > 75%)	15%
Paved curb & storm sewers	20%
Residential – 1/8 acre lot (65% impervious)	30%
Residential – 1/2 acre lot (25% impervious)	35%

Determine an increase in runoff due to the development, total infiltration for pre-development and post-development conditions, if the area receives a total rainfall of 150 mm. Assume AMC (average antecedent moisture condition) type II.

[20 marks]

3. (a) Briefly describe the following terms:
   (i) Saturated zone
   (ii) Unsaturated zone
   (iii) Aquifer
   (vi) Hydraulic Conductivity

[8 marks]

(b) An aquifer has 45% volume of voids from a unit volume of porous medium. It is estimated that 35% of water can be extracted or drained from a unit volume of saturated aquifer material by the force of gravity. Determine the following
   (i) Porosity
   (ii) Specific yield
   (iii) Specific retention

[6 marks]

(c) The saturated medium has a porosity of 0.35 and discharge per unit area of 1×10^{-5} $m^3/s/m^2$. The water level in two observation wells at a distance 500 m apart are 15 m and 10 m for higher end and lower end, respectively. Determine the hydraulic conductivity of the medium and average linear velocity.

[6 marks]

4. (a) Briefly describe **TWO (2)** methods that are commonly used for measurement of stage of a river

[4 marks]

(b) Briefly describe **THREE (3)** methods for estimating the mean velocity along a vertical depth of a river cross section using a current meter.

[6 marks]

(c) The stage and discharge data collected at a particular section of the river by stream gauging operation are shown in Table 1. Determine the following:

(i) Derive a stage-discharge relationship using the data in **Table 1.** Assume at zero discharge the stage is equal to 7.5 m. Determine the coefficient of correlation of derived relationship.

(ii) Calculate the discharge corresponding to stage value of 10.5 m at this gauging section.

[10 marks]

Table 1

Stage (m)	Discharge (m^3/s)	Stage (m)	Discharge (m^3/s)
7.65	15	8.48	170
7.70	30	8.98	300
7.77	57	9.30	500
7.80	59	9.50	700
7.90	70	10.50	900
7.91	100	11.10	1200
8.08	150	11.70	1600

Notes: $Y = aX + b$, $a =$ ————————, $b =$ ————

5. (a) Briefly describe and sketch the following term using related graph:

(i) Time base of hydrograph

(ii) basin lag time (t_p)

(iii) Time of concentration (t_c)

[4 marks]

(b) Discuss the concepts of linearity and superposition in unit hydrograph theory.

[6 marks]

(c) Unit hydrograph is to be developed for a 37.8 km^2 catchment with a lag time of 12 hr. A 2-hr rainfall produced the stream flow data as shown in **Table 2.** Calculate two hour unit hydrograph for this catchment.

Table 2

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24
Stream Flow (m^3/s)	2	1	3	5	9	8	7	6	5	4	3	1	1

[10 marks]

6. The annual maximum recorded floods in a certain river catchment for period 1987-1996 are given in **Table 3.** Verify whether the Gumbel extreme-value distribution fit the recorded value.

(i) Compute the mean and variance of the annual maximum flood series.

(ii) Determine the probability of having an annual maximum flood equal to or greater than 400 m^3/s next year.

(iii) Estimate the magnitude of 100-year return period annual maximum flood.

(iv) Determine the probability of the mean annual maximum flood being equal or exceeded during the next 3 years.

Notes: $K_T = -\sqrt{6}/\pi\{0.5772 + \ln[\ln(T/T-1)]$ and $x_T = \mu + \delta K_T$

Table 3

Year	1987	1988	1989	1990	1991
Max. Flood (m^3/s)	479	429	332	505	690
Year	1992	1993	1994	1995	1996
Max. Flood (m^3/s)	659	370	417	387	270

[20 marks]

1. (a) *Terangkan secara ringkas **EMPAT (4)** komponen kitaran hidrologi.*

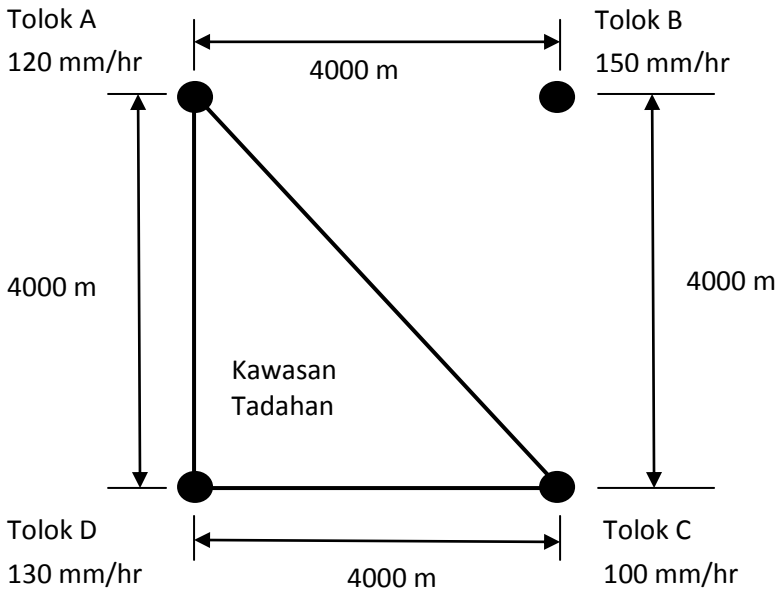
[6 markah]

(b) *Suatu kawasan tadahan dengan luas 1.2 ha menerima jumlah hujan 40 mm (dalam tempoh 30 minit) yang menjanakan isipadu air larian langsung 250 m^3. Tentukan hujan efektif dan kehilangan hidrologik untuk tadahan tersebut.*

[4 markah]

(c) *Lokasi empat tolok hujan untuk suatu kawasan tadahan ditunjukan pada **Rajah 1**. Tentukan purata hujan kawasan menggunakan: i) kaedah Purata Stesen; ii) kaedah Thiessen Poligon.*

[10 markah]



Rajah 1

2. *Suatu kawasan seluas 50 ha yang terdiri dari kumpulan tanah hidrologik B akan dibangunkan untuk kawasan perumahan. Guna tanah untuk keadaan pra-pembangunan (keadaan asal) dan pasca-pembangunan (keadaan setelah pembangunan perumahan dijalankan) adalah seperti berikut:*

Keadaan pra-pembangunan (peratus kawasan):

Kawasan terbuka – lemah (litupan rumput < 50%)	*30%*
Kawasan terbuka – sederhana (litupan rumput 50% - 75%)	*30 %*
Kawasan terbuka – baik (litupan rumput > 75%)	*40 %*

Keadaan pasca-pembangunan (peratus kawasan):

Kawasan terbuka – baik (litupan rumput > 75%)	*15 %*
Bendul berturap & pembentung	*20 %*
Perumahan – 1/8 ekar lot (65% tidak telap)	*30 %*
Perumahan – 1/2 ekar lot (25% tidak telap)	*35 %*

Tentukan pertambahan airlarian disebabkan oleh pembangunan, jumlah penyusupan untuk keadaan pra-pembangunan dan pasca pembangunan, sekiranya kawasan tersebut menerima 150 mm jumlah hujan. Anggapkan keadaan lembapan lampau jenis II.

[20 markah]

3. *(a)* *Terangkan secara ringkas perkara berikut:*

(i) *Zon tepu*

(ii) *Zon tak tepu*

(iii) *Akuifer*

(vi) *Konduktiviti hidraulik*

[8 markah]

(b) *Akuifer mempunyai 45% isipadu liang daripada unit ispadu media berliang. Adalah dianggarkan 35% air boleh dikeluarkan daripada unit isipadu bahan akuifer tepu. Tentukan perkara berikut :*

(i) *Keliangan*

(ii) *Pengeluaran Spesifik*

(iii) *Penahanan Spesifik*

[6 markah]

(c) *Media tepu mempunyai keliangan 0.35 dan kadaralir per unit luas* 1×10^{-5} $m^3/s/m^2$. *Paras air didalam dua telaga pemerhatian yang terpisah sejauh 500 m adalah masing-masing 15 m dan 10 m untuk telaga di hujung atas dan bawah. Tentukan konduktiviti hidraulik dan halaju purata lelurus media tepu tersebut.*

[6 markah]

4. *(a)* *Terangkan secara ringkas **DUA (2)** kaedah yang biasa digunakan untuk pengukuran kedalaman sungai.*

[4 markah]

(b) *Terangkan secara ringkas **TIGA (3)** kaedah untuk menentukan halaju purata disepanjang kedalaman sungai menggunakan jangka arus.*

[6 markah]

(c) *Data kedalaman dan kadar alir sungai yang didapati dari bahagian tertentu sungai melalui operasi pengukuran kadar alir sungai ditunjukkan dalam Jadual 1. Tentukan perkara berikut:*

(i) *Terbitkan hubungan kedalaman-kadaralir menggunakan data dalam **Jadual 1.** Anggapkan kedalaman sungai 7.5 m semasa kadaralir bersamaan dengan 0 (kosong). Tentukan pekali korelasi bagi hubungan yang diperolehi.*

(ii) *Hitung kadaralir yang sepadan dengan kedalaman air 10.5 m pada keratan sungai tersebut.*

Catatan: $Y = aX + b$, $a =$ ——————, $b =$ ———

Jadual 1

Kedalaman (m)	*Kadaralir (m^3/s)*	*Kedalaman (m)*	*Kadaralir (m^3/s)*
7.65	*15*	*8.48*	*170*
7.70	*30*	*8.98*	*300*
7.77	*57*	*9.30*	*500*
7.80	*59*	*9.50*	*700*
7.90	*70*	*10.50*	*900*
7.91	*100*	*11.10*	*1200*
8.08	*150*	*11.70*	*1600*

[10 markah]

5. *(a) Terangkan secara ringkas dan lakarkan menggunakan graf yang sesuai perkara berikut:*

(i) Masa dasar hidrograf

(ii) Lag masa lembangan (tp)

(iii) Masa penumpuan (t_c)

[4 markah]

(b) Bincangkan konsep lelurus dan superposisi di dalam teori unit hidrograf.

[(6 markah]

*(c) Unit hidrograf akan dibangunkan untuk tadahan 37.8 km^2 dengan masa lag 12 jam. Hujan 2-jam menghasilkan data aliran sungai seperti yang ditunjukkan di dalam **Jadual 2**. Hitung dua (2) jam unit hidrograf untuk tadahan tersebut.*

Jadual 2

Masa (jam)	*0*	*2*	*4*	*6*	*8*	*10*	*12*	*14*	*16*	*18*	*20*	*22*	*24*
Kadaralir (m^3/s)	*2*	*1*	*3*	*5*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*1*	*1*

[10 markah]

6. *Banjir maksimum tahunan yang dicatatkan di suatu tadahan sungai bagi tempoh 1987-1996 diberikan di dalam **Jadual 3**. Sahkan sama ada taburan Gumbel nilai-melampau sesuai dengan nilai yang direkodkan.*

(i) Tentukan purata dan varians siri banjir maksimum tahunan.

(ii) Tentukan kebarangkalian banjir maksimum tahunan untuk tahun depan akan sama atau lebih besar daripada 400 m^3/s.

(iii) Anggaran magnitud banjir untuk kala ulangan 100 tahun.

(iv) Tentukan kebarangkalian banjir maksimum tahunan akan sama atau melebihi purata banjir maksimum tahunan untuk tempoh 3 tahun akan datang.

Catatan: $K_T = -\sqrt{6}/\pi\{0.5772 + ln[ln(T/T-1)]$ *and* $x_T = \mu + \delta K_T$

Jadual 3

Tahun	*1987*	*1988*	*1989*	*1990*	*1991*
Banjir Maks. (m^3/s)	*479*	*429*	*332*	*505*	*690*
Tahun	*1992*	*1993*	*1994*	*1995*	*1996*
Banjir Maks. (m^3/s)	*659*	*370*	*417*	*387*	*270*

[20 markah]

Attachment 1
Lampiran 1

Runoff Curve Numbers for Urban Areas

Cover description		Curve numbers for hydrologic soil group –			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's ae assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

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