UNIVERSITI SAINS MALAYSIA

2nd. Semester Examination
2003/2004 Academic Session
Peperiksaan Semester Kedua
Sidang Akademik 2003/2004

Februari / Mac 2004

EAH 325E/3 – Engineering Hydrology

EAH 325E/3 – Hidrologi Kejuruteraan

Duration: 3 hours
Masa : 3 jam

Instructions to candidates:

1. Ensure that this paper contains **EIGHT (8)** printed pages including appendix before you start your examination.
   *Sila pastikan kertas peperiksaan ini mengandungi **LAPAN (8)** muka surat bercetak termasuk lampiran 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 **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.
   Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.

4. Each question **MUST BE** answered on a new page.
   *Tiap-tiap soalan **MESTILAH** dimulakan pada muka surat yang baru.*

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.

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1. (a) Draw a schematic diagram of a hydrologic cycle and show the various components of the hydrologic cycle.

(6 marks)

Lukiskan rajah skematik kitaran hidrologi dan tunjukkan komponen yang terdapat di dalam kitaran hidrologi.

(b) A small catchment of area 150 ha received a rainfall of 10.5 cm in 90 minutes due to a storm. At the outlet of the catchment, the stream draining the catchment was dry before the storm and experienced a runoff lasting for 10 hours with an average discharge value of 2.0 m^3/s. The stream was again dry after the runoff event. (Note: 1 ha = 10,000 m^2).

(i) What is the amount of water which was not available to runoff due to the combined effect of infiltration, evaporation and transpiration?
(ii) What is the ratio of runoff to precipitation (runoff coefficient)?

(7 marks)

Kawasan tadahan seluas 150 ha menerima 10.5 cm hujan dalam masa 90 minit. Sungai yang menyalirkan air daripada kawasan tadahan melalui alur keluar berada dalam keadaan kering sebelum peristiwa hujan tersebut menerima air larian dari tadahan dan membawa kadaralir sebanyak 2.0 m^3/s. Sungai tersebut kembali kering selepas peristiwa air larian. (Nota: 1 ha = 10,000 m^2).

(i) tentukan kehilangan hidrologik (kehilangan disebabkan oleh penyusupan, sejatan dan perpeluhan).
(ii) tentukan nisbah di antara air larian dan hujan (pekali air larian).

(c) For a drainage basin of 30 km^2 isohyetals drawn for a storm gave the following data. Estimate the average depth of the precipitation.

Isohyetals (interval) (cm)	0–1	1–2	2–3	3–4
Inter-isohyetal area (km^2)	5.7	11.4	9.3	3.6

(7 marks)

Isohiet untuk kawasan tadahan seluas 30 km^2 untuk satu peristiwa hujan diberikan dalam jadual di bawah. Tentukan purata kedalaman hujan.

Sela Isohiet (cm)	0–1	1–2	2–3	3–4
Luas diantara Isohiet (km^2)	5.7	11.4	9.3	3.6

2. (a) Name the various methods for estimating mean precipitation over an area.

(4 marks)

Namakan beberapa kaedah untuk menganggarkan purata hujan pada suatu kawasan.

(b) The normal annual precipitation of five rain gauge stations P, Q, R, S and T are respectively 125, 102, 76, 113, and 137 cm. During a particular storm the precipitation recorded by station P, Q, R, and S are 13.2, 9.2, 6.8 and 10.2 cm respectively. The instrument at station T was inoperative during that storm. Estimate the rainfall at station T during that storm.

(8 marks)

Hujan tahunan normal untuk lima tolok hujan P, Q, R, S dan T adalah masing-masing 125, 102, 76, 113, dan 137 cm. Semasa satu peristiwa ribut, jumlah hujan yang di rekodkan oleh stesen P, Q, R, dan S adalah masing-masing 13.2, 9.2, 6.8 dan 10.2 cm. Didapati tolok hujan T tidak berfungsi semasa ribut tersebut. Anggarkan hujan pada stesen T untuk ribut tersebut.

(c) A reservoir had an average surface area of 20 km^2 during June 2002. In that month the mean rate of inflow = 10 m^3/s, outflow = 15 m^3/s, monthly rainfall = 10 cm and change in storage = 16 million m^3. Assume the seepage loss to be 1.8 cm, estimate the evaporation in that month.

(8 marks)

Satu takungan mempunyai purata luas permukaan 20 km^2 pada Jun 2002. Pada bulan tersebut kadar aliran masuk = 10 m^3/s, aliran keluar = 15 m^3/s, hujan bulanan = 10 cm dan perubahan storan = 16 juta m^3. Anggap kehilangan resipan sebanyak 1.8 cm, anggarkan sejatan pada bulan tersebut.

3. (a) Distinguish between the followings:

i. aquifer and aquitard.
ii. influent and effluent stream.

(4 marks)

Nyatakan perbezaan di antara perkara berikut:

i. akuifer dan akuitard.
ii. sungai influen dan sungai efluen.

3. (b) Analysis of data on maximum one-day rainfall depth at Penang indicated that a depth of 280mm had a return period of 50 years. Determine the probability of a one-day rainfall depth equal to or greater than 280mm at Penang occurring;

i. once in 20 successive years
ii. two times in 15 successive years
iii. at least once in 20 successive years

(6 marks)

Analisis data untuk kedalaman hujan maksimum satu hari di Pulau Pinang adalah 280mm dengan purata kala ulangan 50 tahun. Tentukan kebarangkalian kedalaman hujan dalam satu hari bersamaan atau lebih besar dari 280mm di Pulau Pinang berlaku untuk:

i. sekali dalam 20 tahun berturut-turut
ii. dua kali dalam 15 tahun berturut-turut
iii. sekurang-kurangnya sekali dalam 20 tahun berturut-turut.

(c) The drawdown-time data recorded at an observation well situated at a distance of 50 m from the pumping well is given in the table below:

Time from start (min)	1.5	3	4.5	6	10	20	40	100
Drawdown (m)	0.15	0.60	1.0	1.4	2.4	3.7	5.1	6.9

If the well discharge is 1800 lpm, calculate the transmissibility (T) and storage coefficient (S) of the aquifer.

(10 marks)

Data susutan aras-masa yang direkodkan pada satu telaga pemerhatian yang terletak pada jarak 50m dari telaga pengepaman diberikan di dalam jadual di bawah.

Masa (min)	1.5	3	4.5	6	10	20	40	100
Surutan (m)	0.15	0.60	1.0	1.4	2.4	3.7	5.1	6.9

Sekiranya kadaralir telaga adalah 1800 lpm, hitung kebolehpindahan (T) dan kebolehsimpanan (S) akuifer tersebut.

4. (a) Give **FIVE (5)** criteria to be used in the selection of stream gauging station.
(5 marks)

*Nyatakan **LIMA (5)** kriteria yang digunakan untuk memilih lokasi stesen pengukuran kadaralir sungai.*

(b) The velocity for a particular stream is measured at two depths (0.2 and 0.8 of the total depth) for each sub cross-sectional area given in the table below. Estimate the streamflow discharge for the given data.

Section	Sample Depths	1	2	3	4	5
Velocity (m/s)	0.2D	0.4	0.8	1.2	1.0	0.6
	0.8D	0.3	0.6	1.3	1.2	0.6
Area (m^2)		3	6	10	8	4

(15 marks)

Halaju pada stesen pengukuran sungai dicerap pada dua kedalaman (0.2 dan 0.8 daripada jumlah kedalaman) pada setiap sub keratan rentas yang diberikan di dalam jadual di bawah. Anggarkan kadaralir sungai menggunakan data yang diberikan.

Keratan Rentas	Kedalaman Sampel	1	2	3	4	5
Halaju (m/s)	0.2D	0.4	0.8	1.2	1.0	0.6
	0.8D	0.3	0.6	1.3	1.2	0.6
Luas (m^2)		3	6	10	8	4

5. (a) Briefly describe the concept and the use of S-curve.
(4 marks)

Nyatakan konsep dan kegunaan lengkung-S.

5. (b) Determine the streamflow hydrograph resulting from three hour blocks of effective rainfall consists of 10mm between 0600-0900hr, 25mm between 0900-1200hr and 30mm between 1200-1500hr. The 3-hr unit hydrograph and the distribution of base flow are given in the table below.

Ordinate (Hours)	3hr-UH ($m^3/s/mm$)	Time	Effective Rainfall (mm)	Baseflow (m^3/s)
0	0	0600	10	10
3	6.0	0900	25	10
6	9.4	1200	30	9
9	7.1	1500		8
12	5.4	1800		8
15	4.0	2100		9
18	2.9	2400		10
21	1.8	0300		10
24	1.0	0600		11
27	0.4	0900		11
30	0	1200		12
		1500		12
		1800		12
		2100		12
		2400		12

(16 marks)

Tentukan hidrograf kadaralir sungai yang dihasilkan oleh hujan efektif yang terdiri dari 10mm di antara 0600-0900jam, 25mm di antara 0900-1200jam dan 30mm di antara 1200-1500jam. Taburan aliran dasar dan 3-jam unit hidrograf diberikan di dalam jadual di bawah.

Ordinat (Jam)	3jam-UH ($m^3/s/mm$)	Masa	Hujan Efektif (mm)	Aliran Dasar (m^3/s)
0	0	0600	10	10
3	6.0	0900	25	10
6	9.4	1200	30	9
9	7.1	1500		8
12	5.4	1800		8
15	4.0	2100		9
18	2.9	2400		10
21	1.8	0300		10
24	1.0	0600		11
27	0.4	0900		11
30	0	1200		12
		1500		12
		1800		12
		2100		12
		2400		12

6. (a) State **THREE (3)** factors which influence the volume of direct runoff.

(4 marks)

*Berikan **TIGA (3)** faktor yang mempengaruhi isipadu air larian terus.*

(b) A 20 hectares catchment receives a rainfall with an average intensity of 15 mm/hr for three hours. The catchment consists of hydrologic soil group B and the land use is as follows:

20% commercial and business area (85% impermeable)
60% residential area (65% impermeable)
10% paved parking lots, roofs and driveways
10% open spaces with good condition (grass area > 75%)

Determine the total volume of runoff for three hours and its volume for each hour. Determine also the total volume of infiltration for three hours and its volume for each hour. Assume the average antecedent moisture conditions.

(16 marks)

Hujan turun di sebuah kawasan tadahan yang mempunyai keluasan 20 hektar yang terdiri dari kumpulan tanah hidrologik B. Kawasan tadahan tersebut menerima hujan dengan keamatan purata 15 mm/jam untuk 3 jam. Kawasan tadahan terdiri seperti di bawah:

20% kawasan perdagangan (85% tak telus air)
60% kawasan perumahan (65% tak telus air)
10% kawasan letak kereta berturap
10% kawasan terbuka yang baik (litupan rumput > 75%)

Tentukan isipadu air larian untuk tempuh 3 jam dan kuantitinya untuk tiap-tiap jam. Tentukan juga jumlah penyusupan untuk tempoh 3 jam dan kuantitinya untuk tiap-tiap jam. Andaikan lembapan sebelum hujan adalah purata (average antecedent moisture conditions).

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LAMPIRAN

Curve Numbers for Urban Land Uses[a]

COVER DESCRIPTION		CURVE NUMBERS FOR HYDROLOGIC SOIL GROUP			
COVER TYPE AND HYDROLOGIC CONDITION	AVERAGE % IMPERVIOUS AREA[b]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, Cemeteries, etc.)					
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, roof, driveways, etc. (excluding right-of-way)[a]		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)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1-2 in. 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)		77	86	91	94
Idle lands (CNs are determined using cover Types similar to those in Table 4.5).					

Source: Reproduced from U.S. Department of Agriculture, - SCS (1986).

[a]Average runoff condition. Antecedent Moisture Condition (AMC) II, and Ia – 0.2*S'*.

[b]The average percent impervious area shown was used to develop the composite CNs. 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 to open space in good hydrologic condition.

[c]CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

[d]In some warmer climates, a curve number of 95 may be used.