UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2009/2010 Academic Session

April/May 2010

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

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

Please check that this examination paper consists of **NINE (9)** pages of printed material before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.

[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.*]

You may answer the question either in Bahasa Malaysia or English.
[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Enggeris*].

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) Give the expression on water budget equation for a catchment and briefly describe each components of the equation.

[4 marks]

(b) A retention pond has a water surface elevation of 105.5 m above datum at the beginning of January 2010. In that month the retention pond received an average inflow of 8.0m^3/s from surface runoff sources. In the same period the outflow from the retention pond had an average value of 4.5m^3/s. Further in that month, the pond received a rainfall of 210 mm and the evaporation from the lake surface was estimated to be 6.10 cm. Give the water budget equation for the pond and calculate the water surface elevation of the pond at the end of the month. The average pond surface area can be taken as 5500 ha. Assume that the deep percolation has an average value of 0.12mm/hr.

[8 marks]

(c) The rainfall isohyets interval and enclosed inter-isohyets area within basin boundary of 1621 km^2 are given in Table 1. Determine the average precipitation using isohyetal method.

Table 1

Isohyets interval (mm)	15-25	25-51	51-76	76-102	102-127	127-143
Inter-isohyets area (km^2)	80	500	508	300	199	34

[8 marks]

2. (a) A catchment is covered with fair condition grass over 60% of the area. Its 35% area is of soil group B and its 65% area is of soil group C. In a rainstorm it receives 15 cm of total rainfall which was preceded by 6 cm of rainfall during the last five days prior to the beginning of the rainstorm. Determine the amount of infiltration. The curve number for AMC III is given as:

$$CN\,(AMCIII) = \frac{CN\,(AMCII)}{0.43 + 0.0057 \times CN\,(AMCII)}$$

[10 marks]

(b) Field studies suggest the following values for Horton's infiltration parameters: fo = 15 mm/hr, fc = 5 mm/hr, k = 0.6 /hr. Compute the total infiltration for two and four hours by integrating the Horton's equation.

[10 marks]

3. (a) Briefly describe 5 assumptions of principle of Unit Hydrograph.

[8 marks]

(b) The six-hour unit hydrograph of a watershed having drainage area equal to 400 km^2 is as Table 2 :

Table 2

Time (h)	0	6	12	18	24	30	36	42
Unit hydrograph *(m^3/s.cm)*	0	2	30	90	45	15	10	2

For a storm over the watershed having excess rainfall of 5 cm for the first six hours and the 15 cm for the second six hours, compute the streamflow hydrograph, assuming constant baseflow of 80 m^3/s.

[12 marks]

4. (a) The mean annual flow from a particular river basin (1975-2007) is 5.85 m^3/s with variance of 3.99 m^6/s^2. Determine

i. The probability that mean annual flow will not be less than 9 m^3/s;

ii. The 20-year return period mean annual flow;

iii. The probability that the mean annual flow will be less than 4.00 m^3/s in the next 5 consecutive years.

[10 marks]

(b) The ordinates of a 1-hour unit hydrograph at one hour interval in $m^3/s.cm$ are: 0, 2, 15, 20, 10, 4, and 2. Derive the 3- hour unit hydrograph for the basin and calculate the basin area (ha).

[10 marks]

5. (a) A large deep reservoir (K_M=0.36) with a surface area of 500 hectares had the following average values of parameters during a week: water temperature = 20^oC, relative humidity 45%, wind velocity at 1.0 m above ground = 4 m/s. Estimate the average daily evaporation from the lake and the volume of water evaporated from the lake during that one week.

Hint/*tip*: $$e_w = 4.584\, exp\left(\frac{17.27t}{237.3+t}\right)$$

[7 marks]

(b) Using Penman's method, and assume b = 0.52, σ = 2.01 x 10^{-9}, γ = 0.49. Determine the daily PET for the following area:

USM, Nibong Tebal	: June
Latitute	: 5^0 N
Average temperature	: 25.0^0C
Relative humidity	: 45%
Average observed sunshine hours	: 12 hr
Wind speed, U_2	: 25 km/hr
Reflection coefficient	: 0.25

Hint/*tip*: $H_n = H_a(1-r)\left(a+b\frac{n}{N}\right) - \sigma T_a^4\left(0.56-0.092\sqrt{e_a}\right)\left(0.10+0.90\frac{n}{N}\right)$

$E_a = 0.35\left(1+\frac{U_2}{160}\right)(e_w - e_a)$

[13 marks]

6. (a) A current meter with the following rating has been used for the purpose of stream gauging

V = 0.51Ns + 0.03

Where Ns is the rotational speed of the current meter in revolutions per second. Current meter reading was consistently taken at 0.6 depth at all section. Estimate the stream flow in m^3/s and average stream velocity in m/s.

Distance from left water edge (m)	Water depth (m)	Duration of current meter observation (secs)	Current meter reading (revolutions)
0	0	0	0
1	0.9	100	35
3	1.8	100	50
5	2.2	150	102
7	1.9	150	82
9	1.5	100	39
11	0.5	100	24
13	0	0	0

[15 marks]

(b) Briefly describe 5 factors to be considered while selecting the site for water level recording station.

[5 marks]

1. (a) *Berikan persamaan bajet air untuk kawasan tadahan dan terangkan dengan ringkas setiap komponen dalam persamaan tersebut.*

[4 markah]

(b) Permukaan air kolam tadahan berada pada aras 105.5 m pada awal Januari 2010. Dalam bulan tersebut kolam tahanan menerima purata aliran masuk sebanyak 8.0m^3/s dari punca airlarian hujan. Dalam tempoh yang sama purata aliran keluar dari kolam adalah 4.5m^3/s. Hujan yang diterima dikawasan kolam dalam bulan yang sama adalah 210mm dan penyejatan dari permukaan kolam dianggarkan 6.10cm. Berikan persamaan bajet air untuk kolam tahanan dan hitung aras permukaan air kolam pada hujung bulan. Purata keluasan permukaan air kolam adalah 5500 ha. Anggapakan purata penelusan dalam adalah 0.12mm/hr.

[8 markah]

(c) Jeda isohiet dan luas inter-isohiet untuk untuk kawasan tadahan seluas 1621 km^2 diberikan dalam Jadual 1. Tentukan purata kedalaman hujan menggunakan kaedah isohiet.

Jadual 1

Jeda isohiet (mm)	15-25	25-51	51-76	76-102	102-127	127-143
Luas inter-isohiet (km^2)	80	500	508	300	199	34

[8 markah]

2. (a) *Suatu kawasan tadahan mempunyai keadaan litupan rumput sederhana 60% dari kawasan. Seluas 35% dari kawasan terdiri dari jenis kumpulan tanah B dan 65% dari kawasan terdiri dari jenis kumpulan tanah C. Untuk suatu kejadian ribut kawasan tersebut menerima 15 cm jumlah hujan dimana hujan dalam tempoh 5 hari yang lepas sehingga diawal kejadian ribut tersebut adalah 6 cm. Tentukan jumlah penyusupan yang dihasilkan oleh ribut tersebut. Nombor lengkung untuk AMC III diberikan seperti berikut:*

$$CN\,(AMCIII\,) = \frac{CN\,(AMCII\,)}{0.43 + 0.0057 \times CN\,(AMCII\,)}$$

[10 *markah*]

(b) *Kerja lapangan memberikan parameter penyusupan Horton seperti berikut: fo = 15 mm/hr, fc = 5 mm/hr, k = 0.6 /hr. Tentukan jumlah penyusupan untuk dua dan empat jam menggunakan kamilan persamaan Horton.*

[10 *markah*]

3. (a) *Terangkan dengan ringkas 5 anggapan prinsip unit hidrograf.*

[8 *markah*]

(b) *Enam jam unit hidrograf dari suatu kawasan tadahan yang mempunyai luas 393 km^2 seperti Jadual 2 :*

Jadual 2

Waktu (jam)	0	6	12	18	24	30	36	42
Unit hidrograf (m^3/s.cm)	0	2	30	90	45	15	10	2

Untuk suatu hujan lebat terhadap kawasan tadahan mempunyai hujan efektif 5 cm untuk 6 jam pertama dan 15 cm untuk 6 jam kedua, tentukan hidrograf aliran, anggap aliran langsung dasar tetap 80 m^3/s.

[12 *markah*]

4. (a) *Purata kadar alir tahunan dari suatu kawasan tadahan sungai (1975-2007) adalah 5.85 m^3/s dengan variansi 3.99 m^6/s^2. Tentukan*

i. Kebarangkalian purata kadar alir tahunan tidak kurang dari 9 m^3/s;

ii. Purata kadar alir tahunan dengan 20 tahun kaca ulangan;

iii. Kebarangkalian purata kadar alir kurang dari pada 4m^3/s dalam 5 berikutnya.

[10 *markah*]

(b) *Ordinat 1-jam unit hidrograf pada interval satu jam dalam $m^3/s.cm$ adalah: 0, 2, 15, 20, 10, 4, dan 2. Pemerolehan 3-jam unit hidrograf untuk kawasan tersebut dan tentukan luas kawasan tadahan (ha).*

[10 *markah*]

5. (a) *Satu empangan air yang besar dan dalam (K_M=0.36) dengan keluasan permukaan 500 hektar mempunyai nilai purata dalam satu minggu bagi parameter berikut: Suhu air = 20^oC, kelembapan relative = 45%, Kelajuan angina pada 1.0 m di atas permukaan bumi = 4 m/s. Anggarkan sejatan purata harian, dan isipadu air yang tersejat dari tasik dalam satu minggu tersebut.*

Hint/*tip*: $$e_w = 4.584\, exp\left(\frac{17.27t}{237.3+t}\right)$$

[7 *markah*]

(b) *Gunakan kaedah Penman,* dan anggap b = 0.52, σ = 2.01 x 10^{-9}, γ = 0.49. T*entukan PET harian bagi kawasan berikut:*

USM, Nibong Tebal	: June
Latitut	: 5^0 N
Suhu purata	: 25.0^0C
K*elembapan relatif*	: 45%
M*asa purata sinaran matahari*	: 12 hr
Kelajuan angin, U_2	: 25 km/hr
Pekali pemantul	: 0.25

Hint/*tip*: $H_n = H_a(1-r)\left(a+b\frac{n}{N}\right) - \sigma T_a^4\left(0.56-0.092\sqrt{e_a}\right)\left(0.10+0.90\frac{n}{N}\right)$

$E_a = 0.35\left(1+\frac{U_2}{160}\right)(e_w - e_a)$

[13 *markah*]

6. (a) *Satu meter arus yang mempunyai kadar berikut telah digunakan untuk tujuan pengukuran sungai*

V = 0.51Ns + 0.03

Dimana Ns adalah kelajuan pusingan bagi meter arus tersebut dalam pusingan sesaat. Bacaan meter arus telah diambil dengan konsisten pada 0.6 kedalaman di semua bahagian. Anggarkan aliran sungai dalam m^3/s *dan purata kelajuan aliran dalam m/s.*

Jarak dari tepi air kiri (*m*)	*Kedalaman air* (*m*)	*Jangka masa pemerhatian meter arus* (*saat*)	*Bacaan meter arus* (*pusingan*)
0	0	0	0
1	0.9	100	35
3	1.8	100	50
5	2.2	150	102
7	1.9	150	82
9	1.5	100	39
11	0.5	100	24
13	0	0	0

[15 *markah*]

(b) *Terangkan secara ringkas 5 faktor yang perlu diambilkira semasa pemilihan lokasi bagi tapak rekod paras air.*

[5 *markah*]

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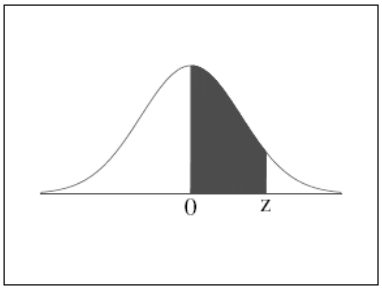
APPENDIX A / *LAMPIRAN A*

Standard Normal Distribution Table



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998

APPENDIX B / *LAMPIRAN B*

Soil Conservation Service Runoff Curve Numbers (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.

APPENDIX C / *LAMPIRAN C*

Table 1: Saturation vapor pressure of water		
Temperature (°C)	Saturation vapor pressure e_w (mm of Hg)	A (mm/°C)
0	4.58	0.30
5.0	6.54	0.45
7.5	7.78	0.54
10.0	9.21	0.60
12.5	10.87	0.71
15.0	12.79	0.80
17.5	15.00	0.95
20.0	17.54	1.05
22.5	20.44	1.24
25.0	23.76	1.40
27.5	27.54	1.61
30.0	31.82	1.85
32.5	36.68	2.07
35.0	42.81	2.35
37.5	48.36	2.62
40.0	55.32	2.95
45.0	71.20	3.66

Table 2: Mean monthly solar radiation at top of atmosphere, H_a (in mm of evaporated water/day)												
North Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	14.5	15.0	15.2	14.7	13.9	13.4	13.5	14.2	14.9	15.0	14.6	14.3
10	12.8	13.9	14.8	15.2	15.0	14.8	14.8	15.0	14.9	14.1	13.1	12.4
20	10.8	12.3	13.9	15.2	15.7	15.8	15.7	15.3	14.4	12.9	11.2	10.3
30	8.5	10.5	12.7	14.8	16.0	16.5	16.2	15.3	13.5	11.3	9.1	7.9
40	6.0	8.3	11.0	13.9	15.9	16.7	16.3	14.8	12.2	9.3	6.7	5.4
50	3.6	5.9	9.1	12.7	15.4	16.7	16.1	13.9	10.5	7.1	4.3	3.0

Table 3: Mean monthly possible values of sunshine hours, N (hours) in north latitude												
North Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10	11.8	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20	11.1	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30	10.4	11.1	12.0	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40	9.6	10.7	11.9	13.2	14.4	15.0	14.7	13.8	12.5	11.2	10.0	9.4
50	8.6	10.1	11.8	13.8	15.4	16.4	16.0	14.5	12.7	10.8	9.1	8.1