UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2007/2008

April 2008

EAH 325/3 – Engineering Hydrology
[Hidrology Kejuruteraan]

Duration: 3 hours
[Masa : 3 jam]

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

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

*[**Arahan**: Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan. 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 Inggeris.]

All questions **MUST BE** answered on a new page.
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

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) Briefly describe the hydrology cycle and its processes.

(6 marks)

Terangkan dengan ringkas tentang kitaran hidrologi dan proses-proses yang berkaitan dengannya.

(b) The observed precipitation for a cluster of eight rain gauges and area of corresponding polygon within basin boundary of 1621km^2 is given in table below. Determine the average depth of the precipitation using Thiessen polygon method.

Cerapan hujan untuk satu rangkaian lapan tolok hujan dan luas polygon untuk kawasan tadahan seluas 1621km^2 diberikan dalam jadual di bawah. Tentukan purata kedalaman hujan menggunakan kaedah Thiessen.

Observed Precipitation (mm) *Cerapan Hujan (mm)*	16.5	37.1	48.8	68.3	39.1	75.7	127.0	114.3
Area of corresponding polygon (km^2) *Luas poligon (km^2)*	18	311	282	311	52	238	212	197

(6 marks)

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

Jeda isohiet dan luas inter-isohiet untuk untuk kawasan tadahan seluas 1621 km^2 diberikan dalam jadual di bawah. Tentukan purata kedalaman hujan menggunakan kaedah isohiet.

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

(8 marks)

2.(a) Briefly describe four main factors which can affect the infiltration proses.

(5 marks)

Secara ringkas terangkan empat faktor utama yang boleh mempengaruhi proses penyusupan.

(b) Field studies suggest the following values for Horton's infiltration parameters: fo = 15mm/hr, fc = 5mm/hr, k = 0.6/hr. Plot the infiltration curve and compute the total infiltration up to four hours by integrating the Horton's equation or using trapezoidal rule.

(15 marks)

Kerja lapangan memberikan parameter penyusupan Horton seperti berikut: fo = 15mm/hr, fc = 5mm/hr, k = 0.6/hr. Plot lengkung penyusupan dan tentukan jumlah penyusupan sehingga empat jam menggunakan kamilan persamaan Horton atau prinsip trapezoidal.

3.(a) Briefly describe the following:

i. superposition principle
ii. s-curve
iii. convolution method

(6 marks)

Terangkan dengan ringkas perkara berikut:

i. prinsip superposisi
ii lengkung-s
iii. kaedah pelingkaran

(b) The six-hour unit hydrograph of a watershed having a drainage area of 393km^2 is given in the table below. For a storm over watershed having excess rainfall of 5cm for the first six hours and 10cm for the second six hours, compute the streamflow hydrograph, assuming constant baseflow of 20m^3/s.

Time (h) Masa (jam)	0	6	12	18	24	30	36	42
Unit hydrograph (m^3/s/cm) Unit hidrograf (m^3/s/cm)	0	1.8	30.9	85.6	41.8	14.6	5.5	1.8

(14 marks)

6-jam unit hidrograf dari suatu kawasan tadahan sungai seluas 393km^2 diberikan dalam jadual di bawah. Untuk suatu kejadian hujan ribut di dalam kawasan tadahan mempunyai hujan efektif 5cm untuk 6 jam yang pertama dan 10cm untuk 6 jam yang kedua, hitung hidrograf aliran sungai, dengan anggapan aliran dasar 20m^3/s.

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4. (a) The mean and standard deviation of annual rainfall at a station are 2100 mm and 445 mm respectively. By using normal distribution determine the following:

i. The probability that annual rainfall will be greater than 3000 mm.
ii. The probability that annual rainfall will be less than 1000 mm.
iii. The 50-year return period mean annual rainfall at the station.

(12 marks)

Suatu stesen pengukur hujan mempunyai purata tahunan sebanyak 2100mm dan sisehan piawai 445mm. Dengan menggunakan taburan normal, tentukan perkara berikut:

i. Kebarangkalian bahawa purata hujan tahunan lebih besar dari 3000mm.
ii. Kebarangkalian bahawa purata hujan tahunan lebih kecil dari 1100mm.
iii. Magnitud purata hujan tahunan dengan kala kembali 50-tahun.

(b) How many times a five-year flood will occur on an average in a 15-year period. By using Binomial distribution:

i. Compute the probability that exactly this number of floods will occur in a 15-year period.
ii. Determine the probability that a 5-yr flood will occur 2 times in 15-yr period.

(8 marks)

Berapa kali banjir 5 tahun kala kembali akan berlaku secara purata dalam tempoh 15 tahun. Dengan menggunakan taburan Binomial:

i. Hitung kebarangkalian jumlah tersebut berlaku dalam tempoh 15 tahun.
ii. Tentukan kebarangkalian bahwa banjir 5 tahun kala kembali akan berlaku 2 kali dalam tempoh 15 tahun.

5. (a) Using Penman's method, determine the daily Potential evaporation for the following area:

Gunakan kaedah Penman, tentukan Potensi penyejatan harian bagi kawasan berikut:

Bukit Kayu Hitam	: June
Latitut / Latitute	: 5^0 N
Average temperature / *Suhu purata*	: 20.5^0C
Crop cover / *Litupan tumbuhan*	: FWS
Cloud cover / *Linkungan Awan*, n/N	: 0.43
Wind speed / *Kelajuan angin*, U_2	: 2.35m/s
Relative humidity / *kelembapan relatif*	: 82%

$$R_b = \sigma T_a^4 (0.56 - 0.092\sqrt{e})\left(0.10 + 0.90\left(\frac{n}{N}\right)\right),$$

$$E_1 = 0.35(e_s - e)(0.5 + 0.54U_2)$$

(10 marks)

(b) Calculate the daily evaporation from a Class A Pan if the rainfall and depth of water added to raise the water level back to its original depth are shown in the table below (a negative sign indicates that the water is removed from the pan).

Kirakan penyejatan harian bag satu Kelas A Pan sekiranya hujan dan air yang ditambah untuk menaikkan air dalam pan ke paras asal adalah seperti yang ditunjukkan dalam jadual di bawah (tanda negatif nenunjukkan air telah dikeluarkan dari pan).

Day/*Hari*	1	2	3	4	5	6	7
Rainfall/*Hujan* (mm)	1.2	0	1.5	1.1	0.5	12.4	0
Water Added/*Air yang ditambah* (mm)	5.6	6.2	2.7	4.5	4.5	-10.3	4.9

If the pan coefficient is 0.84, calculate the Potential evaporation. A pond close by has a surface area of 185 ha, what is the total volume of water evaporated (in m^3) from this pond during these seven days?

Sekiranya pekali pan adalah 0.84, Kirakan Potensi penyejatan. Satu kolam yang berdekatan mempunyai luas permukaan 185 ha, berapakah jumlah isipadu air penyejatan dari kolam dalam tujuh hari tersebut?

(10 marks)

6. (a) Briefly describe the following terms:-

i. Aquifer
ii. Darcy's law
iii. Dupuit's assumption
iv. Saturated zone
v. Water table

(10 marks)

Terangkan secara ringkas istilah berikut:-

i. Akuifer
ii. Hukum Darcy
iii. Anggapan Dupuit
iv. Zon tepu
v. Aras air bumi

(b) Current meter readings were taken at a section of a river as shown in the table below. Calculate the discharge at this point.

Bacaan jangka arus yang telah diambil pada satu keratan rentas sungai adalah seperti ditunjukkan dalam jadual di bawah. Kirakan kadaralir di lokasi tersebut.

Distance from bank/ *Jarak dari tebing* (m)	0	5	15	25	30	35	40	42
Depth/ *Kedalaman* (m)	0	1.8	3.7	9	12.6	10.1	5.3	0
Velocity/*Halaju* @ 0.2D (m/s)			0.15	0.35	0.45	0.40	0.30	
Velocity/ *Halaju* @ 0.6D (m/s)	0	0.10						0
Velocity/*Halaju* @ 0.8D (m/s)			0.25	0.85	1.75	1.20	0.70	

(10 marks)

Appendix / *Lampiran*

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.495	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

Tables of Relevant Values for use
in Penman's Method

Table 1a.

R_a - Incoming Radiation at the top of the atmosphere.
Extraterrestial Radiation. (expressed in mm water/day)

NORTHERN HEMISPHERE

Lat.	90	80	70	60	50	40	30	20	10	0
Month										
JAN	-	-	-	1.4	3.7	6.2	8.1	10.8	12.8	14.6
FEB	-	-	1.1	3.6	6.0	8.4	10.5	12.4	13.9	15.0
MAR	-	1.8	4.1	7.0	9.2	11.1	12.8	14.0	14.8	15.2
APR	7.9	7.8	9.1	11.1	12.7	13.8	14.7	15.2	15.2	14.7
MAY	14.9	14.6	13.6	14.6	15.5	15.9	16.1	15.7	15.0	13.9
JUN	18.1	17.8	17.0	16.4	16.6	16.7	16.5	15.8	14.8	13.4
JUL	16.8	16.5	15.8	15.6	16.1	16.3	16.2	15.8	14.9	13.6
AUG	11.2	10.0	11.4	12.7	13.7	14.7	15.2	15.4	15.0	14.3
SEP	2.9	4.0	6.8	8.5	10.4	12.1	13.5	14.4	14.8	14.9
OCT	-	0.2	2.4	4.7	7.1	9.3	11.2	12.9	14.2	15.0
NOV	-	-	0.1	2.0	4.4	6.8	9.1	11.3	13.1	14.6
DEC	-	-	-	0.9	3.1	5.6	7.9	10.4	12.5	14.3

Appendix / *Lampiran*

Table 1b.

R_a - Incoming Terrestial Radiation in mm water per day.

SOUTHERN HEMISPHERE

Lat.	90	80	70	60	50	40	30	20	10	0
Month										
JAN	17.6	17.3	16.5	16.5	16.9	17.3	17.2	16.8	15.9	-
FEB	10.7	10.5	11.2	12.6	14.1	15.1	15.8	16.0	15.7	-
MAR	1.9	3.6	6.1	8.3	10.4	12.2	13.5	14.5	15.1	-
APR	-	-	1.9	4.3	6.7	8.9	10.9	12.5	13.9	-
MAY	-	-	0.1	1.8	4.1	6.4	8.6	10.7	12.5	-
JUN	-	-	-	0.9	2.9	5.2	7.5	9.7	11.7	-
JUL	-	-	-	1.3	3.4	5.6	7.9	10.1	12.0	-
AUG	-	-	0.8	3.1	5.4	7.6	9.7	11.6	13.1	-
SEP	-	1.3	3.8	6.5	8.7	10.7	12.3	13.6	14.4	-
OCT	7.0	7.1	8.8	10.8	12.5	13.8	14.8	15.3	15.4	-
NOV	15.3	15.0	14.5	15.1	16.0	16.5	16.7	16.4	15.7	-
DEC	14.3	16.9	18.1	17.5	17.6	17.8	17.5	16.9	15.8	-

Table 2

Values of Coefficients "a" and "b"

Latitude MwN and S	Mean Values a	b
54°	0.21	0.55
36°	0.23	0.53
24°	0.28	0.49
13°	0.26	0.50
3°	0.25	0.44

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Appendix / *Lampiran*

Table 3

DURATION OF SUNLIGHT HOURS

Maximum possible duration of sunlight in units of 30 days of 12 hours each.

	North						South			
LAT	50	40	30	20	10	0	10	20	30	40	50
Jan	0.74	0.84	0.90	0.95	1.00	1.04	1.08	1.14	1.20	1.27	1.37
Feb	0.78	0.83	0.87	0.90	0.91	0.94	0.97	1.00	1.03	1.06	1.12
Mar	1.02	1.03	1.03	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08
Apr	1.15	1.11	1.08	1.05	1.03	1.01	0.99	0.97	0.95	0.93	0.89
May	1.33	1.24	1.18	1.12	1.08	1.04	1.01	0.96	0.92	0.80	0.77
Jun	1.36	1.25	1.17	1.11	1.06	1.01	0.96	0.91	0.85	0.78	0.67
Jul	1.37	1.27	1.20	1.14	1.08	1.04	1.00	0.95	0.90	0.84	0.74
Aug	1.25	1.18	1.14	1.11	1.07	1.04	1.01	0.99	0.96	0.92	0.88
Sept	1.06	1.04	1.03	1.02	1.02	1.01	1.00	1.00	1.00	1.00	0.99
Oct	0.92	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.12	1.15	1.19
Nov	0.76	0.83	0.89	0.93	0.98	1.01	1.05	1.09	1.14	1.20	1.29
Dec	0.70	0.81	0.68	0.94	0.99	1.04	1.10	1.15	1.21	1.29	1.41

To obtain the Max. possible duration of sunlight hours per day for a given month multiply 12 with the coefficient.

eg. At latitude 30_0 N during November the possible sunshine hours is 12 * 0.89 = 10.68 hours

Table 4

Values of σT_a^4 in mm of Water

Temperature in ° C-

°C	0	1	2	3	4	5	6	7	8	9
0	11.2	11.4	11.5	11.7	11.9	12.0	12.2	12.3	12.5	12.7
10	12.9	13.1	13.3	13.5	13.7	13 9	14.0	14.2	14.4	14.6
20	14.8	15.0	15.2	15.4	15.6	15.8	16.0	16.3	16.5	16.7
30	16.9	17.1	17.4	17.6	17.8	18.0				

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Appendix / *Lampiran*

Table 5

Temperature and Saturation Vapour Pressure e_s (in mm Hg)

Air Temp				
°C	0+	10+	20+	30+
0.0	4.56	9.09	17.28	31.49
0.5	4.73	9.40	17.83	32.42
1.0	4.90	9.72	18.39	33.37
1.5	5.08	10.04	18.96	34.34
2.0	5.26	10.38	19.55	35.34
2.5	5.45	10.72	20.16	36.36
3.0	5.64	11.08	20.78	37.42
3.5	5.84	11.44	21.42	38.49
4.0	6.05	11.82	22.08	39.60
4.5	6.26	12.21	22.75	40.73
5.0	6.48	12.61	23.45	41.89
5.5	6.71	13.02	24.16	
6.0	6.94	13.44	24.89	
6.5	7.18	13.87	25.64	
7.0	7.43	14.32	26.42	
7.5	7.69	14.78	27.21	
8.0	7.95	15.25	28.02	
8.5	8.22	15.74	28.86	
9.0	8.51	16.24	29.71	
9.5	8.79	16.76	30.59	

Appendix / *Lampiran*

Table 6

Temperature and Δ/γ

Air Temp				
°C	0+	10+	20+	30+
0.5	0.69	1.27	2.25	3.83
1.0	0.71	1.31	2.31	3.92
1.5	0.73	1.35	2.38	4.03
2.0	0.76	1.39	2.44	4.13
2.5	0.78	1.43	2.51	4.24
3.0	0.80	1.47	2.58	4.34
3.5	0.83	1.52	2.65	4.45
4.0	0.86	1.56	2.72	4.57
4.5	0.88	1.61	2.79	4.68
5.0	0.91	1.65	2.87	4.80
5.5	0.94	1.70	2.95	4.92
6.0	0.97	1.75	3.03	5.04
6.5	1.00	1.80	3.11	5.17
7.0	1.03	1.85	3.19	5.30
7.5	1.06	1.90	3.28	5.43
8.0	1.09	1.96	3.36	5.56
8.5	1.13	2.01	3.45	5.70
9.0	1.16	2.07	3.54	5.84
9.5	1.20	2.13	3.63	5.98

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