UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April/May 2009

EAH 325/3 – Engineering Hydrology
[Hidrologi Kejuruteraan]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **TEN (10)** printed pages including appendix before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper consists of **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 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.]

1. a) A well is pumped at a rate of 90 m^3/hour. Drawdown reading over time at an observation well 60 m from the pumped well are recorded in Table 1. Based on these data, determine the value of Storage Coefficient, S and Transmissibility, T using Jacob's Method.

[13 Marks]

Table 1

Time (min)	Drawdown (m)	Time (min)	Drawdown (m)
1.8	0.082	9.8	0.332
2.1	0.092	12.2	0.381
2.4	0.113	14.7	0.427
3.0	0.128	16.3	0.459
3.7	0.153	18.4	0.488
4.9	0.186	21.0	0.516
7.5	0.256	24.4	0.549

b) An aquifer is 22 m thick. Laboratory tests indicate a hydraulic conductivity of 12.777 litre/min/m^2. Test wells located 15.25 m and 38.00 m from the pumping well have a difference in water elevation of 1.1 m. Find the flow rate from the pumping well.

[7 Marks]

2. Use the slope-area method to estimate the stream flow discharge from the following data:

Reach length = 500m

Manning coefficient, n = 0.04

Drop in water surface elevation = 0.5 m

Upstream stream flow area = 21 m^2

Downstream stream flow area = 20 m^2

Upstream wetted perimeter = 12 m

Downstream wetted perimeter = 11.75 m

Upstream velocity head coefficient, α_{vu} = 1.10

Downstream velocity head coefficient, α_{vd}= 1.12

Loss Coefficient, $\Re$ = 1.0

Equation :

$$h_{vu} = \frac{\alpha_u (Q_1 / A_u)^2}{2g}$$

$$h_{vd} = \frac{\alpha_d (Q_1 / A_d)^2}{2g}$$

$$S_2 = \frac{S_1 L + \Re(h_{vu} - h_{vd})}{L}$$

[20 Marks]

3. a) Discuss the hydrologic cycle. Draw a schematic diagram of a hydrologic cycle and show the various components of the hydrologic cycle.

[8 Marks]

b) Briefly discuss the mechanism of infiltration and the factors which affect the infiltration.

[4 Marks]

c) A storm has been measured on a 375 square kilometer catchment. The direct runoff generated from the storm is 3.58 cm and the uniform rainfall depth in the catchment is 11.9 cm. The distribution of rainfall with time is given as Table 2:

Table 2

Time (hr)	9-10	10-11	11-12	12-13	13-14	14-15	Total
Rainfall (cm)	1.02	1.50	1.68	2.60	2.60	2.50	11.90

Calculate Φ-index for the given storm above.

[8 Marks]

4. a) Define the following terms

i) Cyclone

ii) Extratropical cyclone

iii) Anticyclone

iv) Convective precipitation

[5 Marks]

b) For a drainage basin of 600 km^2, isohyetals drawn for a storm are given in Table 3 :

Table 3

Isohyetals (interval) (cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyetal area (km^2)	92	128	120	175	85

Estimate the average depth of the precipitation

[5 Marks]

c) Describe a procedure for checking and correcting inconsistency in rainfall data records.

[5 Marks]

d) A catchments area has **SEVEN (7)** rain gauge stations. In a year the annual rainfall recorded by the gauges are as Table 4.

Table 4

Station	P	Q	R	S	T	U	V
Rainfall (cm)	130.0	142.1	118.2	108.5	165.2	102.1	146.9

For a 4% error in the estimate of the mean rainfall, calculate the minimum number of additional stations required to be established in the catchments.

[5 Marks]

5. a) Briefly describe the following :
   i) Stream flow component
   ii) Effective rainfall
   iii) Time of concentration

[6 Marks]

b) The ordinates of a 1-hour UH at one hour interval in m^3/s.cm are: 0, 15, 20, 8, 3, 1 and 0. Calculate the basin area (ha), the S-hydrograph and the two hour UH for the basin.

[14 Marks]

6. a) The record of annual peak flows at a stream gauging station is shown as in Table 5:

Table 5

Year	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1999**
Flow (m^3/s)	**453**	**275**	**169**	**411**	**312**	**199**	**227**	**590**	**354**	**710**

Assuming lognormal distribution, determine the following:

i) The mean and standard deviation

ii) The return period for a discharge ≥ 450 m^3/s

iii) The magnitude of 50-year return period flood.

iv) The probability that mean annual flood will not be exceeded next year.

[12 Marks]

b) Frequency analysis of annual flood series at a river gauging station for the period 1946-1995 gave 100-year return period flood magnitude of 878 m^3/s and 10-yr return period flood of 693 m^3/s. Analysis was done assuming that the historical flood series follows Gumbel's distribution.

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

ii) Determine the return period for flood with magnitude of 950 m^3/s.

iii) Estimate the magnitude of 50-year return period flood.

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

[8 Marks]

(TERJEMAHAN)

1 a) *Air dalam satu telaga telah dipam dengan kadar 90 m^3/jam. Bacaan penurunan paras air mengikut masa pada satu telaga pemerhatian 60 m dari telaga yang dipam adalah dicatat seperti Jadual 1. Berdasarkan data yang diberikan, tentukan nilai bagi Pekali Storan, S dan Kebolehpindahan, T dengan mengunakan Kaedah Jacob.*

[13 Markah]

Jadual 1

Masa (min)	***Penurunan (m)***	***Masa (min)***	***Penurunan (m)***
1.8	0.082	9.8	0.332
2.1	0.092	12.2	0.381
2.4	0.113	14.7	0.427
3.0	0.128	16.3	0.459
3.7	0.153	18.4	0.488
4.9	0.186	21.0	0.516
7.5	0.256	24.4	0.549

1. b) *Akuifer mempunyai ketebalan 22 m. Ujian amali menunjukkan nilai konduktiviti hidrolik bersamaan dengan 12.777 liter/min/m^2. Ujian ke atas perigi permerhatian yang berada 15.25 m dan 38.00 m dari perigi pengepaman juga menunjukkan perbezaan paras air sebanyak 1.1 m. Kirakan kadar alir dari perigi pengepaman tersebut.*

[7 Markah]

2. *Gunakan kaedah luas-cerun untuk menganggarkan kadar alir sungai berdasarkan data-data berikut:*

Panjang ruas sungai = 500m

Pekali Manning, n = 0.04

Penurunan paras permukaan air = 0.5 m

Keluasan aliran air di hulu = 21 m^2

Keluasan aliran air di hilir = 20 m^2

Panjang lilitan basah di hulu = 12 m

Panjang lilitan basah di hilir = 11.75 m

Pekali turus halaju di hulu, α_{vu} = 1.10

Pekali turus halaju di hilir, α_{vd}= 1.12

Pekali kehilangan, $\mathfrak{R}$ = 1.0

Persamaan :

$$h_{vu} = \frac{\alpha_u (Q_1 / A_u)^2}{2g}$$

$$h_{vd} = \frac{\alpha_d (Q_1 / A_d)^2}{2g}$$

$$S_2 = \frac{S_1 L + \Re(h_{vu} - h_{vd})}{L}$$

[20 Markah]

3. a) *Lakarkan gambarajah kitaran hidrologi. Nyatakan dan bincangkan kitaran hidrologi dan komponennya.*

[8 Markah]

b) *Bincangkan mekanisma penyusupan dan faktor yang mempengaruhi kadar penyusupan.*

[4 Markah]

c) *Suatu ribut telah diukur pada suatu kawasan tadahan seluas 375 km persegi. Air larian terus dari ribut didapati 3.58 cm dan kedalaman hujan sekata kawasan tadahan tersebut ialah 11.9 cm. Taburan masa ribut diberikan seperti Jadual 2 :*

Jadual 2

Masa (jam)	*9-10*	*10-11*	*11-12*	*12-13*	*13-14*	*14-15*	*Jumlah*
Hujan (cm)	*1.02*	*1.50*	*1.68*	*2.60*	*2.60*	*2.50*	*11.90*

Kirakan indek- Φ bagi ribut tersebut.

[8 Markah]

4. a) *Nyatakan dengan ringkas perkara berikut :*

i) Cyclone

ii) Extratropical cyclone

iii) Anticyclone

iv) Hujan Convective

[5 Markah]

b) *Isohiet hujan untuk kawasan tadahan seluas 600 km^2 diberikan seperti Jadual 3 :*

Jadual 3

Isohiet (jeda) (cm)	*15 – 12*	*12 – 9*	*9 – 6*	*6 – 3*	*3 – 1*
Luas Antara-isohiet (km^2)	*92*	*128*	*120*	*175*	*85*

Anggarkan purata hujan untuk kawasan tadahan tersebut.

[5 Markah]

c) *Terangkan kaedah untuk menyemak dan pembetulan rekod hujan yang tidak konsisten.*

[5 Markah]

d) *Jumlah hujan tahunan untuk setahun pada suatu kawasan tadahan yang diukur dari* ***TUJUH (7)*** *stesen tolok hujan adalah seperti Jadual 4:*

Jadual 4

Stesen	*P*	*Q*	*R*	*S*	*T*	*U*	*V*
Hujan (cm)	*130.0*	*142.1*	*118.2*	*108.5*	*165.2*	*102.1*	*146.9*

Tentukan jumlah minima stesen tolok hujan tambahan yang perlu disediakan di dalam kawasan tadahan untuk mencapai 4% ralat dalam anggaran purata hujan.

[5 Markah]

5. a) *Terangkan dengan ringkas perkara berikut :*

   i) komponen aliran sungai

   ii) Hujan effektif

   iii) Masa penumpuan

   [6 Markah]

   b) *Ordinat 1-jam unit hidrograf pada jeda masa satu jam dalam m^3/s.cm adalah: 0, 15, 20, 8, 3, 1 dan 0. Tentukan luas kawasan tadahan (ha), S-hidrograf dan 2-jam unit hidrograf untuk kawasan tersebut.*

   [14 Markah]

6. a) *Rekod aliran puncak tahunan pada suatu stesen pengukur aliran diberikan seperti Jadual 5:*

Jadual 5

Tahun	***1981***	***1982***	***1983***	***1984***	***1985***	***1986***	***1987***	***1988***	***1989***	***1990***
Isipadu kadar alir (m^3/s)	***453***	***275***	***169***	***411***	***312***	***199***	***227***	***590***	***354***	***710***

Buat anggapan taburan lognormal, tentukan :

(i) Purata dan sisihan piawai

(ii) Kala kembali untuk isipadu kadar alir ≥ 450 m^3/s

(iii) Magnitud banjir untuk 50-tahun kala kembali

(iv) Hitung kebarangkalian purata banjir tahunan tidak akan lebih besar tahun hadapan.

[12 Markah]

b) *Analisis frekuensi urutan banjir tahunan pada suatu stesen pengukur sungai untuk tempoh 1945-1995 menghasilkan 100-tahun kala kembali banjir dengan nilai 878 m^3/s dan 10-tahun kala kembali banjir 693 m^3/s. Analisis dilakukan dengan anggapan bahawa sejarah urutan banjir mengikuti taburan Gumbel's.*

i) Tentukan Banjir tahunan purata dan varians urutan banjir tahunan.

ii) Tentukan kala ulangan banjir dengan magnitud 950 m^3/s.

iii) Hitung magnitud banjir untuk 50-tahun kala kembali.

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

[8 Markah]

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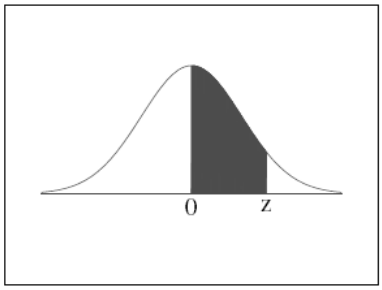
APPENDIX / LAMPIRAN

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