UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

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

Duration: 3 hours
[Masa: 3 jam]

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

Instructions: Answer **FIVE** (5) questions. All questions carry the same marks.
*[**Arahan**: Jawab **LIMA** (5) soalan. Semua soalan membawa jumlah markah yang sama.*

You may answer the question in English except one question should be answered in Bahasa Malaysia.
[Anda dibenarkan menjawab soalan dalam Bahasa Inggeris kecuali satu soalan mestilah dijawab dalam Bahasa Malaysia.]

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] Describe **FIVE (5)** factors which should be considered in the selection of stream flow gauging station.

(5 marks)

*Terangkan **LIMA (5)** faktor yang perlu diambil kira dalam pemilihan stesen pengukuran kadaralir sungai.*

1. [b] Describe **THREE (3)** methods for estimating the mean velocity along a vertical depth of a river using a current meter.

(5 marks)

*Terangkan **TIGA (3)** kaedah penganggaran purata halaju di sepanjang kedalaman pugak sungai menggunakan jangka arus.*

1. [c] The data for streamflow gauging based on time-area method are given in Table 1 below. The velocity is estimated using current meter taken at 0.6 of the depth at every point of measurement for all sub-sections. Estimate the streamflow using the river current meter rating as follows:

$$V = 0.75\ Ns + 0.05\ (m/s)$$

Where Ns is the rotational speed of the current meter in revolution per second.

(10 marks)

Data pengukuran kadaralir sungai menggunakan kaedah halaju-luas dengan bacaan jangka arus diambil pada 0.6 kedalaman pada semua titik pengukuran diberikan dalam Jadual 1 di bawah. Menggunakan data yang diberikan tentukan kadaralir sungai tersebut berdasarkan perkadaran berikut:

$$V = 0.75\ Ns + 0.05\ (m/s)$$

Di *mana Ns adalah halaju pusingan jangka arus dalam putaran persaat.*

Table 1

Distance from left water edge (m) *Jarak dari tebing kiri air (m)*	Depth (m) *Kedalaman (m)*	Duration of current meter observation (sec) *Tempoh bacaan jangka arus (saat)*	Current meter reading (revolutions) *Bacaan jangka arus (putaran)*
4.0	0.00		
8.0	1.75	110	62
16.0	2.60	120	75
24.0	3.50	100	115
32.0	2.15	130	95
40.0	1.50	100	68
44.0	0.00		

2. [a] Briefly describe the flow components of streamflow.

(5 marks)

Terangkan secara ringkas komponen aliran yang terdapat di dalam kadaralir sungai.

2. [b] Calculate 3-hour and 4-hour unit hydrographs for a drainage basin from the given 1-hour unit hydrograph in the Table 2 below:

Table 2

Time (hr)	0	1	2	3	4	5	6	7	8	9	10	11	12
1-hr UH ($m^3/s/cm$)	0	100	175	350	650	720	690	550	410	325	150	110	0

(15 marks)

Hitung 3-jam dan 4-jam unit hidrograf untuk suatu kawasan tadahan sungai menggunakan 1-jam unit hidrograf yang diberikan dalam Jadual 2.

Jadual 2

Masa (jam)	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1-jam UH ($m^3/s/cm$)	*0*	*100*	*175*	*350*	*650*	*720*	*690*	*550*	*410*	*325*	*150*	*110*	*0*

3. [a] A catchment is covered with fair condition grass over 60% area. Its 35% area is of soil group B and its 65% area is of soil group C. In a rainstorm event it receives 15 cm of total rainfall preceded by 6 cm of rainfall during the last 5 days prior to the beginning of the rainstorm. Determine the amount of direct runoff generated by the given rainstorm. The curve number for AMC III is given as:

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

(10 marks)

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 di mana hujan dalam tempoh 5 hari yang lepas sehingga diawal kejadian ribut tersebut adalah 6 cm. Tentukan jumlah air larian langsung yang dihasilkan oleh ribut tersebut. Nombor lengkung untuk AMC III diberikan seperti berikut:

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

3. [b] The mean annual flow and standard deviation at a riverflow gauging station are 5.30 m^3/s and 3.75 m^3/s, respectively. Using normal distribution determine the following:

i) the probability that mean annual flow will not be less than 8.5 m^3/s.
ii) the 20-year return period mean annual flow at the riverflow gauging station.

(10 marks)

Suatu stesen kadaralir sungai mempunyai purata tahunan sebanyak 5.30 m^3/s dan sisehan piawai 3.75 m^3/s. Dengan menggunakan taburan normal, tentukan perkara berikut:

i. kebarangkalian purata kadar alir tahunan tidak akan kurang daripada 8.5 m^3/s.
ii. magnitud purata aliran tahunan dengan kala kembali 20-tahun.

4. [a] What is a hydrological cycle? Draw a schematic diagram of a hydrological cycle and show the various components of the hydrological cycle.

(6 marks)

Terangkan tentang kitaran hidrologi dan sertakan lakaran yang menunjukkan komponen yang berkaitan dengan kitaran hidrologi.

4. [b] A lake has a water surface elevation of 103.2m above datum at the beginning of a certain month. In that month the lake received an average inflow of 6.0 m^3/s from surface runoff sources. In the same period the outflow from the lake had an average value of 6.5m^3/s. Further in that month, the lake received a rainfall of 145 mm and the evaporation from the lake surface was estimated as 6.10 cm. Calculate the water surface elevation of the lake at the end of the month. The average lake surface area can be taken as 5000 ha. Assume that there is no contribution to or from the ground water storage.

(6 marks)

Sebuah tasek mempunyai paras permukaan air 103.2 m di atas datum pada awal suatu bulan yang tertentu. Dalam bulan tersebut tasik itu menerima purata aliran masuk 6.0 m^3/s yang merupakan air larian permukaan dan aliran keluar 6.5m^3/s. Pada bulan tersebut tasik itu menerima hujan sebanyak 145 mm dan anggaran penyejatan daripada permukaan tasik adalah 6.10 cm. Tentukan paras permukaan air tasik pada hujung bulan tersebut. Anggapkan tidak ada aliran air yang masuk dan keluar daripada storan air bumi. Gunakan keluasan permukaan tasik sebanyak 5000 ha.

4. [c] Far a drainage basin of 8160 km^2 isohyetals drawn for a storm gave the following data. Estimate the average depth of the precipitation.

Kawasan tadahan seluas 8160 km^2 mempunyai isohiet untuk suatu peristiwa ribut seperti di dalam jadual di bawah. Tentukan purata kedalaman hujan yang berlaku.

Isohyetals (interval) (cm) ***Isohiet (jeda) (cm)***	75-85	85-95	95-105	105-115	115-135	135-155
Inter-isohyetal area (km^2) ***Luas Inter-Isohiet (km^2)***	580	2960	2850	1000	610	160

(8 marks)

5. [a] Name the various methods for estimating mean precipitation over an area.

(4 marks)

Berikan beberapa kaedah untuk menganggarkan purata hujan untuk suatu kawasan.

5. [b] There are four rain gauge stations existing in the catchment of a river. The average annual rainfall values at these stations are 800, 620, 400, and 540 mm respectively. If it is desired to limit the error in the mean value of rainfall in the catchment to10% then, determine:

(i) the optimum number of rain gauges for the catchment and
(ii) how many more rain gauges will be required to be installed?

(8 marks)

Suatu kawasan tadahan mempunyai empat (4) tolok hujan dengan purata hujan tahunan adalah 800, 620, 400 dan 540 mm, masing-masing. Sekiranya had ralat maksima yang dibenarkan untuk purata hujan kawasan tadahan tersebut adalah 10%, tentukan perkara berikut:

(i) bilangan tolok hujan optima untuk kawasan tadahan tersebut.
(ii) bilangan tolok hujan tambahan yang perlu dipasang untuk kawasan tadahan tersebut.

5. [c] A reservoir with a surface area of 250 hectares has the following average values of parameters during a week: water temperature = 20°C, relative humidity 40%, wind velocity at 1.0 m above ground = 16 km/h. Coefficient accounting for various other factors K_M = 0.36. Estimate,

(i) the average daily evaporation from the lake and
(ii) the volume of water evaporated from the lake during that one week.

(8 marks)

Suatu takungan dengan keluasan permukaan air 250 hektar mempunyai nilai purata parameter berikut dalam satu minggu: suhu air = 20°C, kelembapan bandingan 40%, halaju angin pada 1.0 m pada aras bumi = 16 km/h. Pekali untuk lain-lain faktor K_M = 0.36. Tentukan perkara berikut:

(i) purata penyejatan harian daripada takungan
(ii) isipadu air yang tersejat daripada takungan dalam tempoh satu minggu.

6. [a] Distinguish between the followings:
(i) Aquifer and aquitard
(ii) Influent and effluent stream

(6 marks)

Terangkan perbezaan di antara perkara berikut:
(i) akuifer dan akuitard
(ii) sungai influen dan efluen

6. [b] Three wells A, B and C tap the same horizontal aquifer. The distance AB=1200m and BC=100m. The well B is exactly south of well A and well C lies exactly to the west of well B. The following are the ground surface elevation and depth of water table below the ground surface in the three wells.

Well	Surface elevation (meters above datum)	Depth of water table (m)
A	200	11
B	179	7
C	202	14

Determine the direction of ground water flow in the aquifer in the area ABC of the wells.

(8 marks)

Telaga A, B dan C mengeluarkan air dari akuifer mendatar yang sama. Jarak AB=1200m dan BC=100m. Telaga B berada tepat di selatan telaga A dan telaga C berada tepat di barat telaga B. Butiran paras permukaan bumi dan kedalaman paras permukaan air bumi di bawah permukaan bumi untuk telaga A, B dan C diberikan dalam Jadual 3.

Jadual 3

Telaga	*Permukaan Bumi (meter di atas datum)*	*Kedalaman Permukaan Air Bumi (m)*
A	*200*	*11*
B	*179*	*7*
C	*202*	*14*

Tentukan arah pengaliran air bumi di dalam kawasan telaga ABC.

6. [c] At a certain point in an unconfined aquifer of 3 km^2 area, the water table was at an elevation of 102.00m. Due to a natural recharge in a wet season, its level rose to 103.20m. A volume of 1.5Mm^3 of water was then pumped out of the aquifer causing the water table to reach a level of 101.20m. Assuming the water table in the entire aquifer to respond in a similar way, estimate:

(i) The specific yield of the aquifer
(ii) The volume of recharge during the wet season

(6 marks)

Paras air bumi di dalam akuifer tak-terkurung dengan keluasan 3 km^2 pada satu titik tertentu adalah 102.00m. Paras air tersebut meningkat kepada 103.20m disebabkan oleh imbuhan semula jadi semasa musim lembap. Isipadu air sebanyak 1.5Mm^3 dipam keluar daripada akuifer menyebabkan perubahan paras air bumi kepada 101.20m. Anggapkan paras air bumi di dalam akuifer tersebut mempunyai tindak balas yang sama, tentukan:

(i) hasil tentu akuifer
(ii) isipadu imbuhan semasa musim lembap

LAMPIRAN

Curve Numbers for Urban Land Uses[d]

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.

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TABLE D.1 Normal Distribution Function Table

$$F(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{-\frac{t^2}{2}} dt$$

z	.0	.0100	.0200	.0300	.0400	.0500	.0600	.0700	.0800	.0900
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.10	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5733
.20	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.30	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.40	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.50	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.60	.7257	.7291	.7324	.7356	.7389	.7422	.7454	.7486	.7517	.7549
.70	.7580	.7611	.7642	.7673	.7703	.7734	.7764	.7793	.7823	.7852
.80	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.90	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.00	.8413	.8437	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.10	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.20	.8849	.8869	.8888	.8906	.8925	.8943	.8962	.8980	.8997	.9015
1.30	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.40	.9192	.9207	.9222	.9236	.9251	.9265	.9278	.9292	.9306	.9319

continued

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TABLE D.1 *(Continued)*

z	.0	.0100	.0200	.0300	.0400	.0500	.0600	.0700	.0800	.0900
1.50	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.60	.9452	.9463	.9474	.9484	.9795	.9505	.9515	.9525	.9535	.9545
1.70	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.80	.9641	.9648	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.90	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.00	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.10	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.20	.9861	.9864	.9868	.9871	.9874	.9878	.9881	.9884	.9887	.9890
2.30	.9893	.9895	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.40	.9918	.9920	.9922	.9924	.9926	.9928	.9930	.9932	.9934	.9936
2.50	.9938	.9940	.9941	.9943	.9944	.9946	.9949	.9948	.9951	.9952
2.60	.9953	.9955	.9956	.9957	.9958	.9960	.9961	.9962	.9963	.9964
2.70	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.80	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.90	.9981	.9982	.9982	.9983	.9983	.9984	.9985	.9985	.9985	.9986
3.00	.9986	.9987	.9987	.9988	.9988	.9988	.9989	.9989	.9990	.9990
3.10	.9990	.9991	.9991	.9991	.9991	.9992	.9992	.9992	.9993	.9993
3.20	.9993	.9993	.9993	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.30	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9996
3.40	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997