UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

Februari / Mac 2003

JAH 431/3 – Hidrologi Kejuruteraan

Masa : 3 jam

Arahan Kepada Calon:

1. Sila pastikan kertas peperiksaan ini mengandungi **LAPAN** (8) muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.

2. 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. Semua soalan mempunyai markah yang sama.

4. Semua jawapan **MESTILAH** dimulakan pada muka surat yang baru.

5. Semua soalan **MESTILAH** dijawab dalam Bahasa Malaysia.

6. Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.

1. (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 berikut:

Tempoh (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)

2. (a) Bincangkan dengan ringkas perkara berikut:

i.   Cyclone
ii. Extratropical cyclone
iii. Anticyclone
iv. Hujan Convective

(5 markah)

(b) Isohyet hujan untuk kawasan tadahan seluas 600 km^2 diberikan seperti berikut:

Isohyetals (interval) (cm)	15–20	12–9	9–6	6–3	3–1
Luas Inter-isohyetal (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 berikut:

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)

3. (a) Bezakan perkara berikut:

    i.   Akuifer dan akuitard
    ii.   Akuifer bebas dan akuifer bocor
    iii.   Sungai influen dan sungai kumbahan
    iv.   Paras air bumi dan paras piezometrik
    v.   Simpanan tentu dan hasil tentu akuifer

(10 markah)

(b) Telaga dengan garis pusat 30 cm yang menusuk akuifer terkurung dipam dengan kadar 1200 liter/min. Surutan pada telaga pemerhatian dengan jarak radial 30m diberikan seperti berikut:

Masa (min)	1.0	2.5	5	10	20	50	100	200	500	1000
Surutan (m)	0.2	0.5	0.8	1.2	1.8	2.5	3.0	3.7	4.4	5.0

Tentukan nilai pekali keterusan (T) dan pekali kebolehsimpanan (S).

(10 markah)

4. (a) Jelaskan perkara berikut:

    i.   Lengkung S
    ii.   Kaedah superposisi
    iii.   Unit Hidrograf

(5 markah)

(b) Hidrograf kadaralir sungai yang dihasilkan oleh suatu peristiwa hujan daripada kawasan tadahan seluas 100 hektar diberikan dalam Jadual 1.0. Dianggarkan aliran dasar untuk sungai tersebut ialah 2.5 m³/s. Tentukan perkara berikut:

    i.   Hidrograf air larian langsung
    ii.   Hujan efektif
    iii.   Unit hidrograf kawasan tadahan

(15 markah)

Jadual 1.0

Masa (jam)	Kadar Sungai (m³/s)
0	2.5
0.15	9.5
0.30	11.5
0.45	18.5
1.00	29.5
1.15	40.5
1.30	48.5
1.45	55.5
2.00	50.5
2.15	41.5
2.30	33.5
2.45	28.5
3.00	19.5
3.15	13.5
3.30	9.5
3.45	5.5
4.00	2.5

5   (a) Berikan **TIGA (3)** faktor yang boleh menyumbang pada peningkatan puncak kadaralir hidrograf air larian langsung.

(5 markah)

(b) Kawasan hutan (woods) seluas 500 hektar yang mempunyai keadaan hidrologik yang sederhana (fair hydrologic condition) akan dibangunkan dengan butiran perubahan guna tanah yang diberikan dalam Jadual 2.0. Tentukan pertambahan air larian disebabkan perubahan guna tanah tersebut untuk peristiwa hujan sedalam 15 cm. Kawasan tadahan terdiri dari tanah kumpulan C dan anggapkan keadaan lembapan lampau purata (average antecedent condition) untuk kedua-dua keadaan guna tanah tersebut.

(15 markah)

Jadual 2.0

Guna Tanah	Keluasan (%)
Lot tempat letak kereta berturap.	15
Jalan berturap dengan bahu jalan dan pembentung air larian ribut.	20
Kawasan perumahan (residential) dengan 65% tak telap air.	15
Kawasan perumahan (residential) dengan 30% tak telap air	50

6.   Rekod purata kadaralir tahunan untuk satu stesen pengukuran kadaralir sungai ditunjukkan pada Jadual 3.0. Menggunakan taburan normal tentukan perkara berikut:

   i.   kebarangkalian purata kadaralir tahunan $\geq 150 \text{ m}^3/\text{s}$
   ii.   kebarangkalian purata kadaralir tahunan $\leq 75 \text{ m}^3/\text{s}$
   iii.   magnitud kadaralir dengan purata ulangan 100 tahun

(20 markah)

Jadual 3.0

Tahun	Purata Kadaralir (m^3/s)	Tahun	Purata Kadaralir (m^3/s)
2000	43.56	1990	73.88
1999	89.45	1989	62.87
1998	53.67	1988	63.22
1997	74.32	1987	55.43
1996	55.87	1986	72.54
1995	92.61	1985	40.65
1994	67.92	1984	55.24
1993	73.88	1983	85.98
1992	49.65	1982	79.32
1991	78.92	1981	61.13

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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.)[c]					
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)[d]		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:					
$\frac{1}{8}$ acre or less (town houses)	65	77	85	90	92
$\frac{1}{4}$ acre	38	61	75	83	87
$\frac{1}{3}$ acre	30	57	72	81	86
$\frac{1}{2}$ 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 (*CN*s are determined using cover types similar to those in Table 5.8).					

Source: Reproduced from U.S. Department of Agriculture,–SCS (1986).
[a]Average runoff condition, Antecendent Moisture Condition (AMC) II, and Ia = 0.2S'.
[b]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.
[c]*CN*s shown are equivalent to those of pasture. Composite *CN*s 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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Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
(Antecedent Moisture Condition II)

LAND USE	TREATMENT OR PRACTICE	HYDROLOGIC CONDITION	HYDROLOGIC SOIL GROUP			
			A	B	C	D
Fallow	Straight row	—	77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
	Contoured and terraced	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Contoured and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded	Straight row	Poor	66	77	85	89
legumes[a]	Straight row	Good	58	72	81	85
or	Contoured	Poor	64	75	83	85
rotation	Contoured	Good	55	69	78	83
meadow	Contoured and terraced	Poor	63	73	80	83
	Contoured and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		—	59	74	82	86
Roads (dirt)[b]		—	72	82	87	89
(hard surface)[b]		—	74	84	90	92

Source: U.S. Department of Agriculture *National Engineering Handbook*, Soil Conservation Service U.S. Department of Agriculture Section 4, Chapter 9, Hydrologic Soil Cover Complexes, 1972. Washington, DC.
[a]Close drilled or broadcast.
[b]Including right-of-way.

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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)

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