UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/10

SUBJECT NAME	:	HYDROLOGY
SUBJECT CODE	:	DFC 2042
COURSE	:	2 DFA & DFT
EXAMINATION DATE	:	APRIL 2010
DURATION	:	2½ HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS EXAMINATION PAPER CONTAINS FOURTEEN (14) PRINTED PAGES

Q1 (a) Explain the definition of hydrology in science area.

(2 marks)

(b) List **four (4)** applications of hydrology area in civil engineering.

(4 marks)

(c) Explain **two (2)** causes that retard the hydrological cycle.

(4 marks)

(d) Give the name of equipment to measure the following meteorology data:

i) Relative humidity
ii) Temperature
iii) Sunshine
iv) Wind speed
v) Rainfall

(5 marks)

(e) A catchment of an area of 15,000km^2 receives an annual rainfall of 50cm/annum. Discharge from the catchment is 160m^3/s. Determine the annual evaporation value (ET) for the catchment.

(10 marks)

Q2 (a) Explain precipitation in the hydrological cycle.

(2 marks)

(b) Explain briefly each of the following:

i) Convective Precipitation
ii) Orographic Precipitation
iii) Cyclonic Precipitation
iv) Paragraph Precipitation

(8 marks)

(c) List the criteria for locating a suitable site for a rain gauge.

(3 marks)

(d) By reference to the Table **Q2(c)**, the rain gauge at station E was out of operation. Calculate the rainfall depth at station E with coordinates (0,0) using the Quadrant Method.

Table Q2(c) : Data of Rain Gauge Stations A, B, C, D and E

Station	A	B	C	D	E
Coordinate	(3,1)	(-2,5)	(-2,-3)	(4,-3)	(0,0)
Rainfall (mm)	44	48	46	50	0

(12 marks)

Q3 (a) Explain briefly **four (4)** meteorological factors that influence evaporation process.

(10 marks)

(c) Use the Penmann Method to determine evapotranspiration (ET) of the data below:

Water Surface Temperature : 26°C
Air Temperature : 32°C
Relative Humidity : 55%
Wind Speed . 38 mi/day
Month : Januari 1999
Latitude : 33° South
r : 0.07
n/D : 65%

(15 marks)

Q4 (a) Define surface runoff.

(2 marks)

(b) What are **four (4)** characteristics of a catchment affecting the formation of water surface?

(10 marks)

(c) Data of stream-gauging at a gauging site are given in Table **Q4(c)**. The rating equation of the current meter is $v = 0.51\ N_s + 0.03$ m/s. Calculate the discharge in the stream.

Table Q4(c) : Data of Stream-Gauging

Distance from left of bank (m)	0	2.0	4.0	6.0	8.0	10.0	12.0	14.0
Depth (m)	0	1.5	2.4	2.9	2.5	1.7	1.2	0
Revolutions of a current meter at 0.6d	0	42	60	115	90	50	40	0
Duration of observation (s)	0	120	120	180	180	120	120	0

(13 marks)

Q5 (a) Explain **three (3)** functions of a hydrograph.

(6 marks)

(b) Give **three (3)** factors that contribute to the formation of water flow in a natural river.

(6 marks)

(c) Give **three (3)** methods of how to separate baseflow in a hydrograph.

(3 marks)

(d) A catchment with an area $0.15km^2$ receives a uniform rainfall for 1 hour with a depth of 30cm and produces a hydrograph as shown in Figure **Q5(c).** By reference to ***Appendix 1*** , determine the index value ϕ for the catchment.

(10 marks)

Q6 (a) Explain the purpose of a flood frequency analysis.

(5 marks)

(b) i) Using Gumbel Probability data in Table **Q6(b)**, determine the peak discharge for 10 years and 100 years return periods.

ii) Based on data in Table **Q6(b)**, estimate the exceedance probability and return period for a flowrate of 25000 m^3/s.

Table Q6(b) : Annual Maximum Flowrate

Year	Flowrate (m^3/s)	Year	Flowrate (m^3/s)	Year	Flowrate (m^3/s)
1938	12200	1960	8600	1982	10800
1939	6060	1961	5660	1983	16000
1940	18300	1962	9420	1984	19500
1941	9250	1963	14100	1985	9730
1942	10400	1964	10300	1986	14200
1943	12200	1965	18800	1987	20500
1944	14900	1966	16500	1988	20100
1945	5040	1967	16500	1989	16200
1946	13800	1968	8310	1990	19300
1947	18700	1969	8510	1991	20300
1948	23500	1970	15400	1992	11700
1949	23500	1971	10300	1993	8650
1950	17200	1972	14800	1994	9080
1951	14000	1973	9590	1995	16800
1952	22100	1974	17300	1996	12200
1953	17700	1975	15100	1997	14400
1954	11800	1976	11700	1998	30400
1955	12900	1977	11300	1999	16800
1956	22000	1978	24000	2000	22300
1957	19200	1979	16300	2001	17200
1958	10200	1980	13500	2002	15200
1959	8030	1981	12500	2003	15300

(20 marks)

S1 (a) Jelaskan definisi hidrologi di dalam bidang sains.

(2 markah)

(b) Senaraikan **empat (4)** penggunaan bidang hidrologi dalam kejuruteraan awam.

(4 markah)

(c) Jelaskan **dua (2)** punca yang boleh mengakibatkan kitaran hidrologi terencat.

(4 markah)

(d) Berikan nama peralatan untuk mencerap data meteorologi seperti di bawah:

i) Kelembapan bandingan
ii) Suhu
iii) Sinaran suria
iv) Kelajuan angin
v) Hujan

(5 markah)

(e) Sebuah kawasan tadahan yang luasnya 15,000km^2 menerima hujan tahunan berkapasiti 50cm/tahun. Manakala kadaralir sungai yang mengalir keluar dari kawasan tadahan adalah 160m^3/s. Kirakan nilai sejatpeluhan tahunan (ET) bagi kawasan tadahan tersebut.

(10 markah)

S2 (a) Jelaskan definisi proses kerpasan di dalam kitaran hidrologi.

(2 markah)

(b) Jelaskan dengan ringkas setiap jenis-jenis kerpasan di bawah:

i) Kerpasan Perolakan
ii) Kerpasan Orografik
iii) Kerpasan Saiklun
iv) Kerpasan Perenggan

(8 markah)

(c) Senaraikan kriteria yang sesuai untuk menempatkan tolok hujan.

(3 markah)

(d) Berdasarkan Jadual **S2(c)**, tolok hujan di stesen E telah tidak berfungsi. Kirakan jumlah hujan di stesen E dengan koordinat (0,0) dengan menggunakan Kaedah Empat Sukuan.

Jadual S2(c) : Data Stesen Tolok Hujan A, B, C, D and E

Stesen	A	B	C	D	E
Koordinat	(3,1)	(-2,5)	(-2,-3)	(4,-3)	(0,0)
Hujan (mm)	44	48	46	50	0

(12 markah)

S3 (a) Jelaskan dengan ringkas **empat (4)** faktor-faktor meteorologi yang mempengaruhi proses penyejatan.

(10 markah)

(b) Dengan menggunakan Kaedah Penmann dalam menganggar penyejatpeluhan (ET), kirakan nilai ET dengan maklumat yang diberi seperti di bawah:

Suhu pada permukaan air : 26°C
Suhu udara persekitaran : 32°C
Kelembapan relatif : 55%
Kelajuan angin : 38 batu/hari
Bulan : Januari 1999
Latitud : 33° Selatan
r : 0.07
n/D : 65%

(15 markah)

S4 (a) Berikan definisi air larian permukaan.

(2 markah)

(b) Apakah **empat (4)** ciri-ciri kawasan tadahan yang mempengaruhi pembentukkan air larian permukaan?

(10 markah)

(c) Berdasarkan Jadual **S4(c)** adalah data yang diperolehi bagi satu kerja pengukuran kadaralir sungai. Persamaan bagi halaju jangka arus adalah $v = 0.51\ N + 0.03$ m/s. Hitungkan kadaralir sungai.

Jadual S4(c) : Data Pengukuran Kadaralir Sungai

Jarak dari tebing (m)	0	2.0	4.0	6.0	8.0	10.0	12.0	14.0
Kedalaman (m)	0	1.5	2.4	2.9	2.5	1.7	1.2	0
Putaran (N) pada 0.6d	0	42	60	115	90	50	40	0
Tempoh pemerhatian (s)	0	120	120	180	180	120	120	0

(13 markah)

S5 (a) Jelaskan **tiga (3)** tujuan asas hidrograf.

(6 markah)

(b) Berikan **tiga (3)** faktor yang menyumbang kepada terbentuknya pengaliran air di dalam sungai.

(6 markah)

(c) Berikan **tiga (3)** kaedah untuk mengasingkan aliran dasar dalam sesuatu hidrograf.

(3 markah)

(d) Satu peristiwa hujan seragam selama 1 jam, berkedalaman 30 cm telah menimpa sebuah kawasan tadahan seluas 0.15 km^2 dan menghasilkan satu hidrograf seperti dalam Figure **S5(c)**. Sila rujuk ***Appendix 1***, kirakan nilai indeks ϕ bagi kawasan tadahan tersebut.

(10 markah)

S6 (a) Jelaskan tujuan analisis frekuensi banjir.

(5 markah)

(b) i) Anggarkan kadar alir puncak untuk kala kembali 10 tahun dan 100 tahun bagi data sungai Jadual **S6(b)** menggunakan taburan kebarangkalian Gumbel.

ii) Berdasarkan data Jadual **S6(b)**, anggarkan kebarangkalian melebihi tahunan dan kala kembali untuk kadar alir 25000 m^3/s dengan menggunakan taburan kebarangkalian Gumbel.

Jadual S6(b): Kadaralir Tahunan Maksimum.

Tahun	Kadar alir (m^3/s)	Tahun	Kadar alir (m^3/s)	Tahun	Kadar alir (m^3/s)
1938	12200	1960	8600	1982	10800
1939	6060	1961	5660	1983	16000
1940	18300	1962	9420	1984	19500
1941	9250	1963	14100	1985	9730
1942	10400	1964	10300	1986	14200
1943	12200	1965	18800	1987	20500
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1952	22100	1974	17300	1996	12200
1953	17700	1975	15100	1997	14400
1954	11800	1976	11700	1998	30400
1955	12900	1977	11300	1999	16800
1956	22000	1978	24000	2000	22300
1957	19200	1979	16300	2001	17200
1958	10200	1980	13500	2002	15200
1959	8030	1981	12500	2003	15300

(20 markah)

APPENDIX 1

FINAL EXAMINATION

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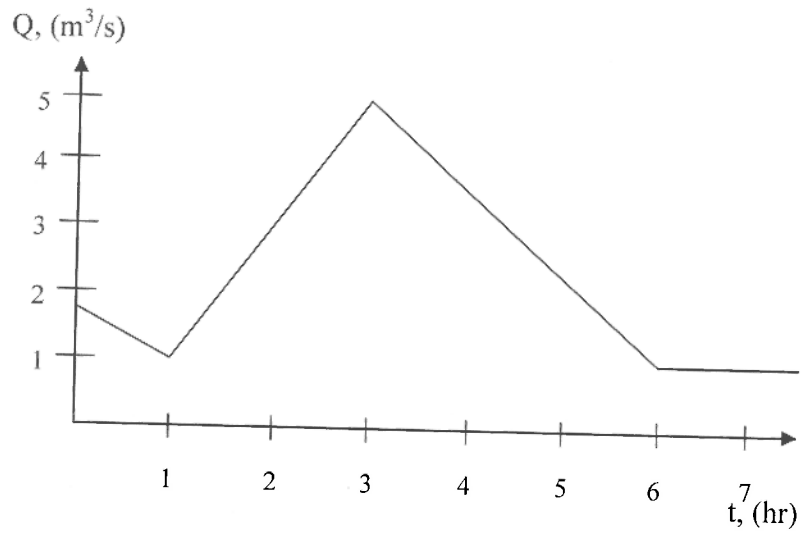

Figure Q5(c) : Hydrograph

APPENDIX 2

FINAL EXAMINATION

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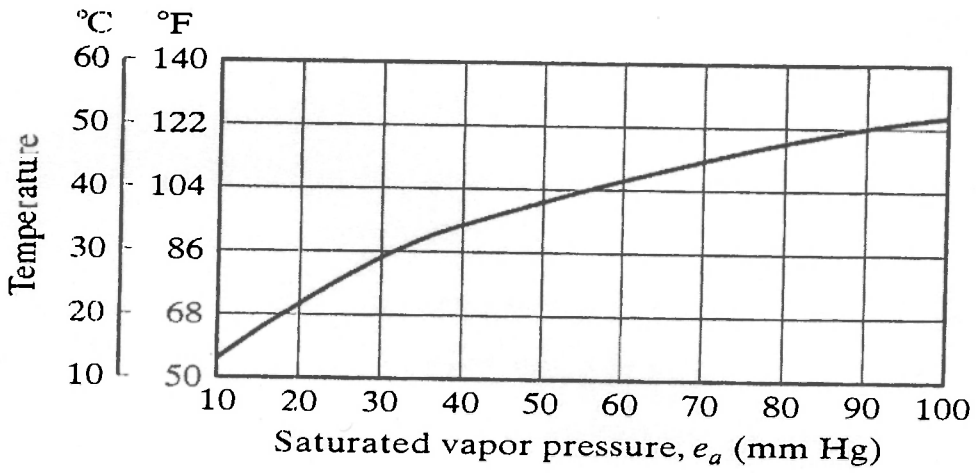

Figure Q3(c) : Saturated Vapor Pressure, e_a

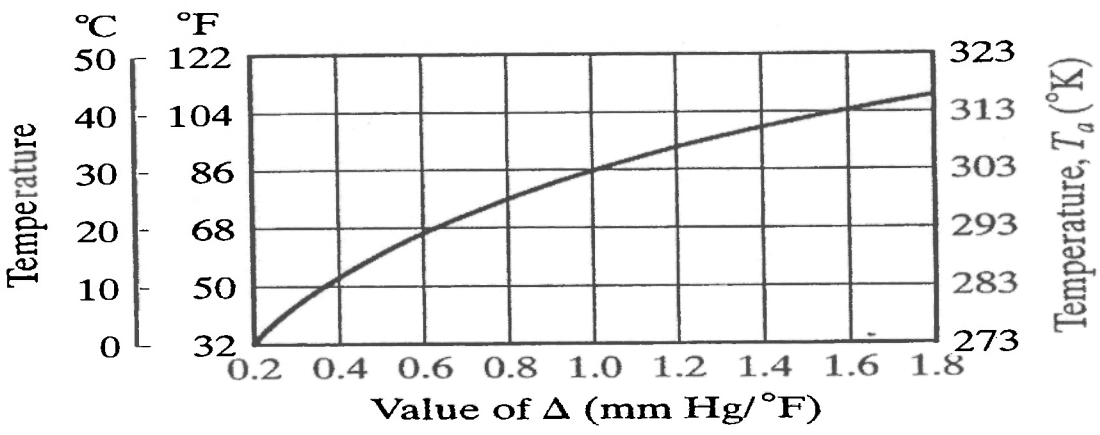

Figure Q3(c) : Value ofΔ (mm Hg/°F)

APPENDIX 3

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Table Q3(c) : Properties of Water

TABLE 3.1 Properties of Water

Traditional U.S. Units

Temperature (°F)	Specific gravity	Unit weight (lb/ft^3)	Heat of vaporization (Btu/lb)	Kinematic viscosity (ft^2/sec)	Vapor pressure		
					mb	psi	in. Hg
32	0.99987	62.416	1073	1.93×10^{-5}	6.11	0.09	0.18
40	0.99999	62.423	1066	1.67×10^{-5}	8.36	0.12	0.25
50	0.99975	62.408	1059	1.41×10^{-5}	12.19	0.18	0.36
60	0.99907	62.366	1054	1.21×10^{-5}	17.51	0.26	0.52
70	0.99802	62.300	1049	1.06×10^{-5}	24.79	0.36	0.74
80	0.99669	62.217	1044	0.929×10^{-5}	34.61	0.51	1.03
90	0.99510	62.118	1039	0.828×10^{-5}	47.68	0.70	1.42
100	0.99318	61.998	1033	0.741×10^{-5}	64.88	0.95	1.94

SI Units

Temperature (°C)	Specific gravity	Density (g/cm^3)	Heat of vaporization (cal/g)	Kinematic viscosity (cs)	Vapor pressure		
					(mm Hg)	(mb)	(g/cm^2)
0	0.99987	0.99984	597.3	1.790	4.58	6.11	6.23
5	0.99999	0.99996	594.5	1.520	6.54	8.72	8.89
10	0.99973	0.99970	591.7	1.310	9.20	12.27	12.51
15	0.99913	0.99910	588.9	1.140	12.78	17.04	17.38
20	0.99824	0.99821	586.0	1.000	17.53	23.37	23.83
25	0.99708	0.99705	583.2	0.893	23.76	31.67	32.30
30	0.99568	0.99565	580.4	0.801	31.83	42.43	43.27
35	0.99407	0.99404	577.6	0.723	42.18	56.24	57.34
40	0.99225	0.99222	574.7	0.658	55.34	73.78	75.23
50	0.98807	0.98804	569.0	0.554	92.56	123.40	125.83
60	0.98323	0.98320	563.2	0.474	149.46	199.26	203.19
70	0.97780	0.97777	557.4	0.413	233.79	311.69	317.84
80	0.97182	0.97179	551.4	0.365	355.28	473.67	483.01
90	0.96534	0.96531	545.3	0.326	525.89	701.13	714.95
100	0.95839	0.95836	539.1	0.294	760.00	1013.25	1033.23

APPENDIX 4

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Table Q3(c) : Coefficient B

TABLE 3.5 Values of Temperature-Dependent Coefficient B for Use in the Penman Equation

T_a (°K)	B (mm H_2O/day)	T_a (°F)	B (mm H_2O/day)
270	10.73	35	11.48
275	11.51	40	11.96
280	12.40	45	12.45
285	13.20	50	12.94
290	14.26	55	13.45
295	15.30	60	13.96
300	16.34	65	14.52
305	17.46	70	15.10
310	18.60	75	15.65
315	19.85	80	16.25
320	21.15	85	16.85
325	22.50	90	17.46
		95	18.10
		100	18.80

Note: $B = \sigma T_a^4$ where σ is the Boltzmann constant, 2.01×10^{-9} mm/day.
Source: After Criddle [23].

Table Q3(c) : Values of R

TABLE 3.6 Tabulated Values of R, Mean Monthly Intensity of Solar Radiation on a Horizontal Surface,[a] for Use in the Penman Equation

	Latitude (deg)	J	F	M	A	M	J	J	A	S	O	N	D
North	60	1.3	3.5	6.8	11.1	14.6	16.5	15.7	12.7	8.5	4.7	1.9	0.9
	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
	40	6.0	8.3	11.0	13.9	15.9	16.7	16.3	14.8	12.2	9.3	6.7	5.5
	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
	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
	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
	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
South	10	15.8	15.7	15.1	13.8	12.4	11.6	11.9	13.0	14.4	15.3	15.7	15.8
	20	16.8	16.0	14.6	12.5	10.7	9.6	10.0	11.5	13.5	15.3	16.4	16.9
	30	17.3	15.8	13.6	10.8	8.7	7.4	7.8	9.6	12.1	14.8	16.7	17.6
	40	17.3	15.2	12.2	8.8	6.4	5.1	5.6	7.5	10.5	13.8	16.5	17.8
	50	17.1	14.1	10.5	6.6	4.1	2.8	3.3	5.2	8.5	12.5	16.0	17.8
	60	16.6	12.7	8.4	4.3	1.9	0.8	1.2	2.9	6.2	10.7	15.2	17.5

[a] Measured in mm H_2O evaporated per day.
Source: After Criddle [23].

APPENDIX 5

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EQUATIONS

$$S = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_i - \overline{X})^2 \right]^{0.5}$$

$$b = \frac{1}{0.78\,S}(X - \overline{X} + 0.45\,S)$$

$$X = \overline{X} + 0.78\,S\,\{ - \ln [- \ln F(x)] - 0.577 \}$$

$$F(x) = e^{-e^{-b}}$$

$H = R_A (1-r)(0.18 + 0.55\ n/D) - B (0.56 - 0.092 e_o^{0.5})(0.10 + 0.9 n/D)$

$R_l = R_A (1 - r) (0.18 - 0.55\ n/D)$

$$R_B = \sigma T_a^4 \left(0.56 - 0.092\sqrt{e_o}\right)\left(0.10 + 0.90\frac{n}{D}\right)$$

$E_0 = 0.35 (e_a - e_o) (1 + 0.0098\ u_2)$

$$ET = \frac{\Delta H + 0.27\,E_0}{\Delta + 0.27}$$

$$\Delta Q_1 = y_i \left(\frac{W_i}{2} + \frac{W_{i+1}}{2} \right) v_i$$

$$\overline{W_1} = \frac{\left[W_1 + \frac{W_2}{2} \right]^2}{2W_1}$$

$$\overline{W_N} = \frac{\left[W_N + \frac{W_{N-1}}{2} \right]^2}{2W_N}$$