UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT NAME	:	HYDROLOGY
SUBJECT CODE	:	BFC 3092
COURSE	:	3 BFF
EXAMINATION DATE	:	APRIL/MAY 2010
DURATION	:	2 ½ HOURS
INSTRUCTIONS	:	PART A: ANSWER **QUESTION 1** PART B: ANSWER ANY **THREE (3)** QUESTIONS.

THIS PAPER CONSISTS OF FIFTEEN (15) PAGES

PART A

Q1 (a) Explain briefly
(i) Aquifer
(ii) Confined aquifer
(iii) Saturated zone
(iv) Transmissivity

(8 marks)

(b) The banks of a stream consist of silty clay of hydraulic conductivity 0.005 m/day having an average depth of 150 cm. The underlying aquifer of fine sand has an average thickness of 20 m. Given the hydraulic conductivity of fine sand = 3.2 m/day. Determine:

(i) The coefficient of leakage,
(ii) The retardation coefficient
(iii) The leakage factor

(6 marks)

(c) (i) A well is pumped from a confined aquifer at a rate of 0.14 m^3/s for a long time. In two observation wells located 100 and 30 m away from the well, the difference in elevation has been observed as 1.5 m. What is the transmissivity of the aquifer?

(4 marks)

(ii) A fully penetrating 50 cm diameter main well has its bottom 34.8 m below the static water table. After 24 hr of pumping at 0.09 m^3/s, the water level in the main well stabilizes to 5 m below the static water table. A draw-down of 3.2 m is noticed in an observation well 100 m away from the pumped well. Determine the hydraulic conductivity of the aquifer.

(7 marks)

PART B

Q2 (a) The Department of Irrigation and Drainage (DID) has a significant number of dam projects for water supply. Explain the advantages and disadvantages of a dam project with respect to hydrologic cycle for water resources development.

(5 marks)

(b) An amount of 4.5 cm of water evaporates over a period of two days from a vertical walled reservoir in a 150 hectare catchment area. The reservoir also receives storm water at a flow rate of 5.5 m^3/s during this period. Compute the volume of water released in hectare-cm during the 2-days period assuming the water level in the reservoir remains the same.

(7 marks)

(c) (i) Describe briefly **three (3)** types of precipitation.

(6 marks)

(i) Estimate the missing precipitation depth (cm) using the quadrant method for the data tabulated below.

Table Q2: Precipitation Data

Quadrant	Gauge	Precipitation Depth (cm)	Coordinates (x,y)
I	A	12.2	6,15
	B	11.4	14,8
II	C	9.9	7,-8
	D	10.2	14,-8
IV	E	14.2	-9,10
	F	10.7	-18,7
	G	9.9	-15,19

(7 marks)

Q3 (a) Define
(i) evapotranspiration potential
(ii) evapotranspiration actual

(4 marks)

(b) Calculate the daily evaporation rate for a stream, assuming the following:

Mean value for air temperature = 85° F
Mean value for water temperature = 60° F
Average wind speed = 19 mph
Relative humidity = 35%.
Assume C = 0.35

Use the Mayer and Dunne equations and the information given in **Appendix 1.**

(8 marks)

(c) (i) What is Index Φ?
(ii) Describe briefly the Horton infiltration model.
(ii) The rainfall intensities during each 30 min duration of a 150-min storm over a 500 km^2 basin are 5.5, 3, 1, 3.5, and 2 mm/hr, respectively. The direct runoff from the basin is 105 mm^3. Determine Φ Index.

(13 marks)

Q4 (a) Explain briefly the following:

i. Catchment area.
ii Time of concentration

(4 marks)

(b) By referring to Figure **Q4(b)**, compute the peak run-off, Q_p, for a 10-year storm using Rational Method for a drainage basin of 15 km^2 and having the following properties:

i. Stream: length 5000 meter; slope 0.4%

ii. Run-off coefficient:
- Impervious, 3.0 km^2 ; c = 0.90,
- Grass, 8.0 km^2 ; c = 0.35,
- Wooded, 4.0 km^2; c = 0.25.

(8marks)

(c) (i) Explain **two (2)** factors affecting surface runoff
(ii) Salt solution of concentration 5.7 g/l was injected to a stream at a constant rate of 8.5 ml/s. At a sufficient distance downstream, the salt concentration of the stream was measured to be 0.05 mg/l. Estimate the stream discharge.

(13 marks)

Q5 (a) (i) Define Unit hydrograph (UH).

(ii) Explain how watersheds respond as linear systems in unit hydrographs.

(5 marks)

(b) Determine the 4 hour unit hydrograph using the data in Table **Q5 (b)** for a watershed having a drainage area of 200 km^2, assuming a constant baseflow of 20 m^3/s.

Table Q5 (b): Flow Data

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44
Flow (m^3/s)	20	25	75	175	225	180	100	80	60	40	25	20

(7 marks)

(c) Derive the 2 hr Snyder unit hydrograph for a 70 km^2 catchment where the main stream is 15 km long and the distance from the catchment outlet to the point on the stream nearest to the centriod of the catchment is 6 km. Given $C_p = 0.6$ and $C_t = 1.5$.

(13 marks)

Q6 (a) Table **Q6 (a)** shows the annual maximum discharges for a river. Using the normal distribution method, estimate the exceedance probabilities and return period for a discharge of 350 m^3/s and flood magnitudes for a probability of 0.01.

Table Q6 (a): Annual maximum discharges (m^3/s)

273	114	374	294
382	158	430	251
547	202	609	228
377	146	388	209
246	116	328	191

(13 marks)

(b) For the inflow hydrograph of a catchment area as indicated in **Table Q6 (b)**, perform a flood routing through a river reach given K = 20 hours and x = 0.25.

Table Q6 (b): Inflow hydrograph of a river

Time,(hour)	12	24	36	48	60	72	84	96	108	120
Inflow ,I (m^3/s)	100	300	680	500	400	310	230	180	100	50

(12 marks)

BAHAGIAN A

S1 (a) Dengan ringkas,terangkan

(i) Akuifer
(ii) Akuifer terkurung
(iii) Zon tepu
(iv) Transmissiviti

(8 marks)

(b) Tebing sebuah sungai pada bahagian dasarnya mengandungi tanah liat berkelodak dengan nilai pekali kebolehtelapan ialah 0.005 m/hari serta mempunyai purata kedalaman 150 cm. Lapisan akuifer pasir halus di bawahnya mempunyai purata ketebalan 20 m. Diberi pekali kebolehtelapan untuk pasir halus = 3.2 m/hari. Kenalpasti

(i) pekali kebocoran,
(ii) pekali pembantutan
(iii) faktor kebocoran

(6 marks)

(c) (i) Sebuah tclaga dipam dari akuifer tcrkurung pada kadar 0.14 m^3/s untuk satu jangka masa yang lama. Pada dua buah telaga pengawasan yang terletak 100 dan 30 m dari telaga, perubahan aras dikenalpasti sebanyak 1.5 m antara kedua-duanya. Apakah transmissiviti untuk akuifer itu?

(4 markah)

(ii) Sebuah telaga utama yang berdiameter 50 cm mempunyai jarak ketinggian 34.8 m di bawah aras statik air bawah tanah. Setelah 24 jam dipam pada kadar 0.09 m^3/s, aras air bawah tanah di dalam telaga utama menjadi stabil kepada 5 m di bawah aras statik air bawah tanah. Susutan sebanyak 3.2 cm dikenalpasti di telaga pemerhatian yang terletak 100 m dari telaga yang dipam. Kenalpasti pekali kebolehtelapan untuk akuifer itu.

(7 markah)

BAHAGIAN B

S2 (a) Jabatan Pengairan dan Saliran (JPS) terlibat dengan pelbagai projek-projek empangan untuk bekalan air. Terangkan kelebihan dan kekurangan sebuah projek empangan terhadap kitaran hidrologi untuk pembangunan sumber air.

(5 markah)

(b) Sejumlah 4.5 cm air tersejat dalam masa dua hari dari takungan yang mempunyai struktur dinding menegak, berkeluasan 150 hektar. Takungan tersebut juga menerima hujan ribut sebanyak 5.5 m^3/s sepanjang tempoh tersebut. Kirakan isipadu air yang dilepaskan dalam hectare-cm bagi tempoh itu jika aras air di dalam takungan adalah sama pada permulaan dan pengakhiran tempoh.

(7 markah)

(c) (i) Terangkan secara ringkas **tiga (3)** jenis kerpasan.

(6 markah)

(iii) Anggarkan kedalaman kerpasan (dalam cm) yang hilang menggunakan kaedah sukuan bagi taburan data yang berikut.

Jadual S2: Data taburan kerpasan.

Sukuan	Tolok	Kedalaman kerpasan	Koordinat (x,y) (cm)
I	A	12.2	6,15
	B	11.4	14,8
II	C	9.9	7,-8
	D	10.2	14,-8
IV	E	14.2	-9,10
	F	10.7	-18,7
	G	9.9	-15,19

(7 markah)

S3 (a) Definisikan
(i) sejatpeluhan potensi
(ii) sejatpeluhan sebenar

(4 markah)

(b) Kira kadar penyejatan harian untuk sebuah sungai dengan andaian yang berikut:

Purata suhu udara = 85° F
Purata suhu air = 60° F
Purata halaju angin = 19 batu/jam
Kelembapan relative = 35%.
Andaikan C = 0.35

Gunakan persamaan Mayer and Dunne serta maklumat yang diberikan di **Appendix 1.**

(8 markah)

(c) (i) Apakah Φ indeks?
(ii) Huraikan secara ringkas model penyusupan Horton.
(iii) Keamatan hujan untuk setiap sela masa 30 min bagi ribut bertempoh 150-min untuk kawasan seluas 500 km^2 adalah 5.5,3, 1, 3.5, and 2 cm/hr masing-masing. Air larian terus dari tadahan adalah sebanyak 105 cm^2. Kenalpasti Φ indeks.

(13 markah)

S4 (a) Terangkan secara ringkas:

i. Kawasan tadahan.
ii Masa penumpuan

(4 markah)

(b) Dengan merujuk Figure **Q4 (b),** kira kadar alir puncak Q_p, bagi ribut berkala kembali 10 tahun menggunakan Kaedah Rasional untuk keluasan kawasan 15 km^2 dan mempunyai parameter-parameter tersebut:

i.)Sungai: panjang 5000 meter; kecerunan 0.4%
ii.)Pekali air larian:
- Tidak telap, 3.0 km^2 ;c = 0.90,
- Berumput, 8.0 km^2 ; c = 0.35,
- Hutan, 4.0 km^2; c = 0.25.

(8markah)

(c) (i) Terangkan **dua (2)** faktor yang mempengaruhi air larian permukaan.
(ii) Larutan garam yang mempunyai kepekatan 5.7 g/l telah dimasukkan ke dalam sungai pada kadar malar iaitu 8.5 ml/s. Pada satu jarak tertentu di hilir sungai, kepekatan garam tersebut diukur dan didapati nilainya 0.05 mg/l. Anggarkan kadar alir sungai tersebut.

(13 markah)

S5 (a) (i) Definisikan hidrograf unit (UH).

(ii) Terangkan bagaimana kawasan tadahan berfungsi seperti sistem linear di dalam hidrograf unit .

(5 markah)

(b) Kenalpasti hidrograf unit bertempoh 4 jam menggunakan data di **Jadual S5** bagi kawasan tadahan berkeluasan 200 km^2 dengan menganggapkan aliran dasar adalah malar iaitu 20 m^3/s.

Jadual S5: Data Jumlah Aliran

Masa (jam)	0	4	8	12	16	20	24	28	32	36	40	44
Aliran(m^3/s)	20	25	75	175	225	180	100	80	60	40	25	20

(7 markah)

(c) Terbitkan Unit hidrograf Snyder bertempoh 2 jam untuk kawasan tadahan berkeluasan 70 km^2 di mana panjang sungai utama adalah 15 km dan jarak dari luahan tadahan ke titik paling hampir dengan sentriod tadahan adalah 6 km. Diberi $C_p = 0.6$ and $C_t = 1.5$.

(13 markah)

S6 (a) Jadual **S6(a)** menunjukkan hujan tahunan maksimum untuk sebuah sungai. Menggunakan kaedah taburan seragam, anggarkan kebarangkalian melebihi dan kala kembali bagi aliran 350 m^3/s dan magnitud banjir bagi kebarangkalian 0.01.

(13 markah)

Jadual S6 (a): Aliran maksimum tahunan (m^3/s)

273	114	374	294
382	158	430	251
547	202	609	228
377	146	388	209
246	116	328	191

(b) Untuk hidrograf masukan bagi kawasan tadahan seperti yang dinyatakan dalam **Jadual S6(b)**, lakukan penghalaan banjir bagi muara sungai itu dengan diberi K = 20 jam dan x = 0.25.

Jadual S6(b): Hidrograf masukan untuk sungai

Masa(jam)	12	24	36	48	60	72	84	96	108	120
Aliran masuk, I(m^3/s)	100	300	680	500	400	310	230	180	100	50

(12 markah)

APPENDIX 1

FINAL EXAMINATION

SEMESTER / SESSION : SEM 2 / 2009/2010 COURSE : 3 BFF
SUBJECT : HYDROLOGY SUBJECT CODE : BFC 3092

Table Q3 (b)(i) : Properties of Water in Traditional U.S. Units

Temperature	Vapor pressure		
(°F)	in Hg	mb	psi
32	0.18	6.11	0.09
40	0.25	8.36	0.12
50	0.36	12.19	0.18
60	0.52	17.51	0.26
70	0.74	24.79	0.36
80	1.03	34.61	0.51
90	1.42	47.68	0.70
100	1.94	64.88	0.95

Table Q3 (b(ii) : Properties of Water in SI Units

Temperature	Vapor pressure		
(°C)	mm Hg	mb	g/cm^2
0	4.58	6.11	6.23
5	6.54	8.72	8.89
10	9.20	12.27	12.51
15	12.78	17.04	17.38
20	17.53	23.37	23.83
25	23.76	31.67	32.30
30	31.83	42.43	43.27
35	42.18	56.24	57.34
40	55.34	73.78	75.23
50	92.56	123.40	125.83
60	149.46	199.26	203.19
70	233.79	311.69	317.84
80	355.28	473.67	483.01
90	525.89	701.13	714.95
100	760.00	1013.25	1033.23

APPENDIX 2

FINAL EXAMINATION

SEMESTER / SESSION : SEM 2 / 2009/2010 COURSE : 3 BFF
SUBJECT : HYDROLOGY SUBJECT CODE : BFC 3092

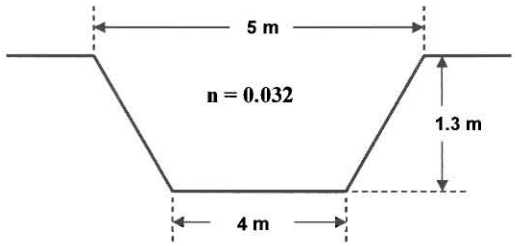

FIGURE Q4(b)(i) : Cross section of stream

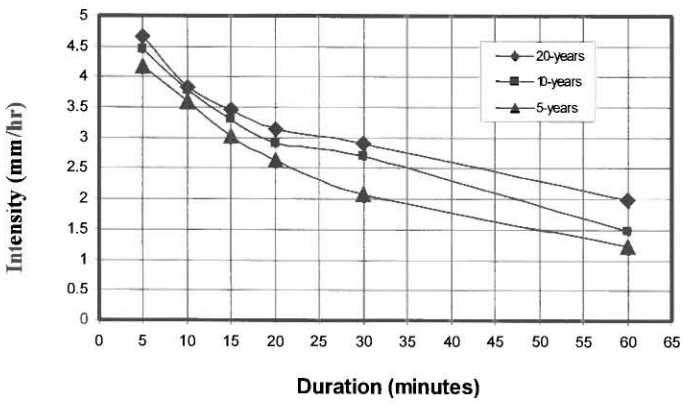

FIGURE Q4(b)(ii): Intensity-Duration-Frequency (IDF) curve

APPENDIX 3

FINAL EXAMINATION

SEMESTER / SESSION : SEM 2 / 2009/2010 COURSE : 3 BFF
SUBJECT : HYDROLOGY SUBJECT CODE : BFC 3092

Table: Values of probability of standard normal deviate, z for a normal distribution (exceedance probability)

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0223
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

APPENDIX 4

FINAL EXAMINATION

SEMESTER / SESSION : SEM 2 / 2000/2010 COURSE : 3 BFF
SUBJECT : HYDROLOGY SUBJECT CODE : BFC 3092

Equations:

$I - O = \Delta S/\Delta t$

$Q_p = \frac{1}{3.6} \times C \times i \times A$ (For SI Unit)

$E = C(e_0 - e_a)\left[1 + \frac{W}{10}\right]$

$v = (R^{2/3})(s^{1/2})/n$

$C_0 = \frac{0.5\Delta t - Kx}{K(1-x) + 0.5\Delta t}$

$C_1 = \frac{0.5\Delta t + Kx}{K(1-x) + 0.5\Delta t}$

$C_2 = \frac{K(1-x) - 0.5\Delta t}{K(1-x) + 0.5\Delta t}$

$xI+(1-x)O$

$H^2 - h^2 = \frac{Q}{\pi K}\ln\left(\frac{R}{r}\right)$

$H - h = \frac{Q}{2\pi bK}\ln\left(\frac{R}{r}\right)$

1 in = 25.4 mm

1 mile = 1.6093 km

1Hg = 1.333mb

$Le = \frac{K'}{b'}$

$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{X})^2$

$W = I / L^2$

$P_X = \frac{\Sigma (P / W)}{\Sigma W}$

$E = (0.013 + 0.00016u_2)e_a\left[(100 - R_h)/100\right]$

$\text{Index } \phi = \frac{P - R}{t_e}$

$Q = \frac{(C_1 - C_2)}{(C_2 - C_0)}q$

$T_B = 72 + 3t_{IR}$

$T_B = 5t_{IR}$

$t_l = 0.75\, C_t\, (LL_c)^{0.3}$

$t_r = \frac{t_l}{5.5}$

$t_{IR} = t_l + 0.25\,(t_R - t_r)$

$t_p = \frac{t_R}{2} + t_{IR}$

$Q_{pR} = 2.78\frac{C_v A}{t_{IR}}$

$W_{50} = \frac{5.87}{(Q_{pR}/A)^{1.08}}$

$W_{75} = \frac{3.35}{(Q_{pR}/A)^{1.08}}$

$a = \frac{K}{K'/b'} \qquad b = \sqrt{\frac{Kb}{K'/b'}}$

$z = \frac{X - \bar{X}}{S} \qquad X = \bar{X} + zS$