UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2015/2016 Academic Session

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EAH325 – Engineering Hidrology
[Kejuruteraan Hidrologi]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **TEN (10)** pages of printed material including **ONE (1)** appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat yang bercetak termasuk **SATU (1)** lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
*[**Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.]*

All questions **MUST BE** answered on a new page.
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. [a] A reservoir has the inflow and outflow rate of 18 m^3/s and 7 m^3/s, respectively. Storage at 8.00 AM on a day is 230 Ha.m. Calculate the storage at 2.00 PM on the next day.

Sebuah takungan mempunyai aliran masuk dan keluar masing-masing sebanyak 18 m^3/s dan 7 m^3/s. Storan pada 8.00 AM untuk suatu hari adalah sebanyak 230 Ha.m. Kirakan storan pada 2.00 PM hari berikutnya.

[5 marks/*markah*]

[b] The annual rainfall data for 6 stations are 1280, 1440, 1200, 1090, 1660, and 1030 mm, respectively. Using 7% error in estimating the mean rainfall data, calculate the minimum number of additional stations required to represent the basin.

Data hujan tahunan untuk 6 stesen adalah 1280, 1440, 1200, 1090, 1660, dan 1030 mm. Menggunakan 7% ralat dalam anggaran purata data hujan, kira bilangan minimum stesen tambahan yang diperlukan untuk mewakili kawasan tadahan secukupnya.

[4 marks/*markah*]

[c] Basin A is represented by a rectangular plot of 10 km x 12 km and has 4 rain gauge stations. Fit a coordinate system to the plot such that the side of 10 km represents the x-axis. The storm rainfall and coordinates of the stations are as in **Table 1**. Calculate the average rainfall of the plot by Thiessen Polygon method.

*Kawasan tadahan A diwakili oleh segi empat tepat berukuran 10 km x 12 km mempunyai 4 tolok hujan. Sesuaikan satu sistem koordinat yang mana sisi 10 km diwakili oleh paksi-x. Hujan ribut dan koordinat stesen adalah seperti **Jadual 1**. Kirakan purata hujan plot tersebut menggunakan kaedah Poligon Thiessen.*

Table 1: Rain Gauges and Rainfall data of Basin A/
Jadual 1*: Tolak Hujan dan Data Hujan bagi Tadahan A*

Station/ *Stesen*	Station Coordinate/ *Koordinat Stesen*	Rainfall (cm)/ Hujan (cm)
A	(1,3)	12
B	(8,11)	11.4
C	(3,10)	13.2
D	(7,5)	14.6

[11 marks/*markah*]

2. [a] Explain various data needed to apply Penman's equation for estimating the potential evapotranspiration from a given area.

Terangkan data yang diperlukan untuk applikasi formula Penman bagi menganggar sejat transpirasi pada sesuatu kawasan.

[6 marks/*markah*]

[b] The weather data at a reservoir in Pulau Pinang are shown in **Table 2**. Calculate the mean monthly evaporation for January, February and March for the reservoir. Given:

$$e_w = 4.584 \exp\left(\frac{17.27t}{237.3+t}\right)$$

Data cuaca di sebuah takungan di Pulau Pinang ditunjukkan dalam ***Jadual 2****. Kirakan purata penyejatan bagi bulan Januari, Februari dan Mac untuk takungan tersebut.*
Diberi:

$$e_w = 4.584 \exp\left(\frac{17.27t}{237.3+t}\right)$$

Table 2: Weather data at the reservoir/
Jadual 2: *Data cuaca di takungan.*

Month/ *Bulan*	Temperature (°C)/ *Suhu (°C)*	Relative humidity (%)/ *Kelembapan relatif (%)*	Wind velocity at 2m above ground level (km/h)/ *Kelajuan angin 2 m dari aras tanah (km/h)*
Jan	27.3	85	5.0
Feb	30.5	82	7.0
Mar	29.7	71	4.0

[14 marks/*markah*]

3. [a] The earth materials form potential water bearing reservoirs. On the basis of their capacities to hold water between their intergranular spaces, these materials can be classified into **FOUR (4)** categories. With the aid of diagrams, explain these **FOUR (4)** categories.

*Bahan bumi membentuk potensi takungan galas air. Berdasarkan kapasiti untuk menyimpan air di antara butiran ruang bahan, bahan-bahan ini boleh dikelaskan kepada **EMPAT (4)** kategori. Dengan bantuan gambarajah, terangkan **EMPAT (4)** kategori ini.*

[6 marks/*markah*]

[b] Two rivers A and B shown in **Figure 1** are separated by confined and unconfined aquifers formation of 6.4 km. Compute the seepage flow per unit length of the river if K value in the upper region and lower region are similar (K = 18 m/day).

Dua sungai A dan B yang ditunjukkan dalam ***Rajah 1*** *dipisahkan oleh pembentukan akuifer terkurung dan tak terkurung sepanjang 6.4 km. Kirakan aliran resapan per unit panjang sungai jika nilai K di bahagian atas dan bahagian bawah adalah sama (K = 18 m/hari).*

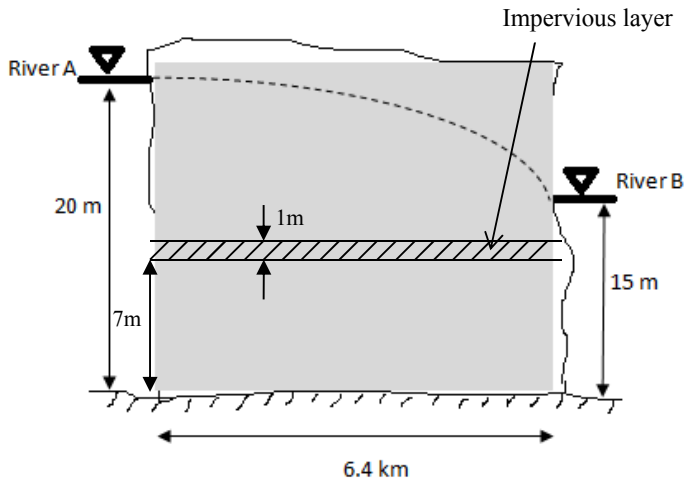

Figure 1 / ***Rajah 1***

[14 marks/*markah*]

4. [a] Streamflow represents the runoff phase of the hydrologic cycle and provides important basic data for hydrologic studies. Describe **FIVE (5)** reasons why streamflow measurements are important in hydrologic studies.

Aliran sungai mewakili fasa air larian dalam kitaran hidrologi dan memberikan data asas yang penting untuk kajian hidrologi. Terangkan ***LIMA (5)*** *sebab mengapa pengukuran aliran sungai adalah penting dalam kajian hidrologi.*

[5 marks/*markah*]

[b] Area Velocity Method is most frequently used for discharge measurements in natural streams. With the aid of sketch diagram, explain in details the Area Velocity Method.

Kaedah Luas Halaju paling kerap digunakan untuk mengukur kadar aliran sungai semula jadi. Dengan bantuan gambarajah lakaran, terangkan secara terperinci mengenai Kaedah Luas Halaju.

[7 marks/*markah*]

[c] Common salt solution of concentration 200 gm/l was added to a stream at a constant rate of 0.2 cm^3/s. The existing concentration of the salt in the stream is 0.01 ppm. At the downstream, the concentration of the salt in the stream water is measured as 0.05 ppm. Calculate the stream discharge.

Kepekatan garam biasa 200 gm/l telah disuap ke dalam sungai pada kadar tetap dengan 0.2 cm^3/s. Kepekatan sedia ada garam dalam aliran sungai adalah 0.01 ppm. Di bahagian hilir, kepekatan garam yang di ukur di dalam air sungai itu adalah 0.05 ppm. Kirakan kadar alir sungai.

[8 marks/*markah*]

5. The occurrence of six hour of continuous rainfall in Kampung Jambu has resulted into flooding and disruption to the community. The effective rainfall at 2 hour interval for six hour is given in **Table 3**. The solution of effective plan for flood mitigation requires an estimation of direct runoff volume generated from the effective rainfall event given in **Table 3**. The 1 hr-UH for the area provided by the consultant firm is given in **Table 4**. Calculate the peak discharge and volume of direct runoff using the information given in **Table 3** and **Table 4**.

*Kejadian hujan berterusan selama enam jam telah menyebabkan banjir di Kampung Jambu dan menganggu komuniti. Hujan efektif dengan sela masa 2 jam bagi enam jam diberikan di dalam **Jadual 3**. Penyelesaian untuk tebatan banjir yang efektif memerlukan maklumat isipadu air larian terus yang dijanakan oleh kejadian hujan yang diberikan dalam **Jadual 3**. Syarikat Perunding telah menyediakan 1-jam UH untuk kawasan tersebut diberikan dalam **Jadual 4**. Kirakan puncak aliran dan isipada air larian terus menggunakan maklumat yang diberikan dalam **Jadual 3** dan **Jadual 4**.*

[20 marks/*markah*]

Table 3 / *Jadual 3*
Effective Rainfall/*Hujan Efektif*

Time (hr) *Masa (jam)*	Effective Rainfall (mm) *Hujan Efektif (mm)*
0 - 2	120
2 - 4	160
4 - 6	110

Table 4 / *Jadual 4*
1-hr UH/*1-jam UH*

Ordinate (hr) *Ordinat (j)*	1-hr UH *($m^3/s/cm$)*
0	0
1	40
2	80
3	130
4	170
5	140
6	130
7	80
8	50
9	30
10	0

6. [a] Describe **THREE (3)** examples of application of design flood discharge in infrastructure project during planning and design stages.

*Terangkan **TIGA (3)** contoh aplikasi rekabentuk kadaralir banjir bagi projek infrastruktur di peringkat perancangan dan rekabentuk.*

[6 marks/*markah*]

[b] Majlis Perbandaran Seberang Perai plans to construct a road in Southern Seberang Perai, Penang. The design of the platform of the road requires some analysis on the flood probability and magnitude. The mean and variance of the 40 years of annual streamflow record in the locality are 120 m^3/s and 30 m^6/s^2, respectively. Assuming the data is normally distributed, calculate the following:

Majlis Perbandaran Seberang Perai merancang untuk membina jalan di Seberang Perai Selatan, Pulau Pinang. Rekabentuk pelantar jalan tersebut memerlukan analisis kebarangkalian dan magnitud banjir. Purata dan varians untuk 40 tahun rekod kadar alir tahunan adalah masing-masing, 120 m^3/s dan 30 m^6/s^2. Dengan anggapan data menunjukan taburan normal, tentukan perkara berikut:

[i] the probability of average annual streamflow discharge ≥ 130 m^3/s

kebarangkalian purata kadar alir tahunan ≥ 130 m^3/s

[ii] the probability of average annual streamflow discharge ≤ 100 m^3/s

kebarangkalian purata kadar alir tahunan ≤ 100 m^3/s

[iii] the probability of average annual streamflow discharge ≥ 100 m^3/s

kebarangkalian purata kadar alir tahunan ≥ 100 m^3/s

[iv] the magnitude of average annual streamflow discharge with 200 year return period.

magnitud purata tahunan kadar alir dengan 200 tahun kala ulangan.

[14 marks/*markah*]

APPENDIX / *LAMPIRAN*

Normal Distribution Table

Normal Deviate z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-4.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.7	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.6	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
-3.5	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
-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	.0233
-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
-.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483

	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0	0.004	0.008	0.012	0.016	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.091	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.148	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.17	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.195	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.219	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.258	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.291	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.334	0.3365	0.3389
1	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.377	0.379	0.381	0.383
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.398	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.437	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.475	0.4756	0.4761	0.4767
2	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.483	0.4834	0.4838	0.4842	0.4846	0.485	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.489
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.492	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.494	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.496	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.497	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.498	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.499	0.499
3.1	0.499	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

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