Second Semester Examination
2021/2022 Academic Session

July/August 2022

EAH325 – Engineering Hydrology

Duration : 2 hours

Please ensure that this examination paper consists of **NINE (9)** pages of printed material before you begin the examination.

Instructions: This paper contains **FIVE (5)** questions**,** answer any **FOUR (4)** questions.

All questions **MUST BE** answered on a new page.

1. (a) Describe **THREE (3)** factors that will affect the evaporation process.

[6 marks]

(b) A Class A pan was set up adjacent to a lake. At the beginning of a certain week, the water level inside the pan was 203 mm. Later in that week, there was a 41 mm of rainfall water. Subsequently, 22 mm of water was removed from the pan to keep the water level within the specified depth range. Calculate the pan evaporation and the lake evaporation if the depth of the water in the pan at the end of the week is 189 mm. Use a suitable pan coefficient.

[5 marks]

(c) A reservoir with an average surface spread of 4.5 km^2 in March has a water surface temperature of 20°C and relative humidity of 27%. Wind velocity measured at 2.0 m above the ground at a nearby observatory is 35 km/h. Calculate the average evaporation loss from the reservoir in mm/day, the total depth, and volume of evaporation loss for March.

[14 marks]

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2. (a) With the aid of sketches, describe the following terms:

i) Saturated zone

ii) Unsaturated zone

iii) Aquifuge

iv) Hydraulic conductivity

v) Pumping test

[15 marks]

(b) The saturated medium has a porosity of 0.45 and discharge per unit area of 1×10^{-5} $m^3/s/m^2$. The water level in two observation wells at a distance of 400 m apart are 12 m and 8 m for higher end and lower end, respectively. Determine the hydraulic conductivity of the medium.

[10 marks]

3. (a) There are factors to be considered in the selection of method for water level recording station. With the aid of a sketch, select and explain the most appropriate method that is recommended for discharge measurement near hilly area.

[10 marks]

(b) **Table 1** shows the characteristics of a river reach of 1.5 km apart during a high flood event. Given velocity head coefficient, 1.12 and loss coefficient, 1.0. Calculate the discharge of the river.

[15 marks]

TABLE 1

Upstream:	Cross-sectional area	A_1	=	170 m^2
	Wetted perimeter	P_1	=	50 m
	Manning's roughness coefficient	n_1	=	0.03
	Reduced level of water		=	77.3 m

Downstream:	Cross-sectional area	A_2	=	175 m^2
	Wetted perimeter	P_2	=	51 m
	Manning's roughness coefficient	N_2	=	0.025
	Reduced level of water		=	77.0 m

4. The 2-hr Unit Hydrograph for a river basin in Northern Seberang Perai is given in **Table 2**. Determine the catchment area and volume of direct runoff due to effective rainfall given in **Table 3**. Use superposition method in the determination of direct runoff hydrograph.

[25 marks]

Table 2 The 2-hr Unit Hydrograph

Ordinate (hr)	0	1	2	3	4	5	6	7	8	9	10	11	12
UH ($m^3/s/cm$)	0	5	18	28	35	45	47	37	25	16	9	3	0

Table 3 Effective Rainfall Hyetograph

Time (hr)	Rainfall Depth (mm)
0 - 2	50
2 - 4	90
4 - 6	60

5. (a) The platform for a residential development is designed for 100 years (return period) flood. Determine the following for the residential area:

i) The exceedance probability of 100 years flood.

ii) The probability of no flooding in 10 years period.

iii) The probability of no flooding in the first 5 years and flooding in the 6^{th} year.

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iv) Probability at least one flood will occur in 10 years.

v) Determine the return period if the risk is 20% that the residential area will be flooded at least once during the next 5 consecutive years.

[10 marks]

(b) Local authority plans to construct a road in Southern Seberang Perai. The design of the platform of the road requires some analysis on the flood probability and magnitude. The mean and variance of the 100 years of annual streamflow record in the locality are 120 m^3/s and 30 m^6/s^2, respectively. Assuming the data is log-normally distributed, determine the followings:

i) the return period for a streamflow discharge ≥ 150 m^3/s.

[8 marks]

ii) the magnitude of 50-year return period flood.

[7 marks]

ATTACHMENT

Types of pan	Average value	Range
Class A Pan	0.70	0.60-0.80
Colorado Sunken Pan	0.78	0.75-0.86
USGS Floating Pan	0.80	0.70-0.82

Formulas

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

$$u_9 = u_h\left(\frac{h_1}{h}\right)^{1/7}$$

$$E_L = K_M(e_w - e_a)\left(1+\frac{u_9}{16}\right)$$

$$E_a = 0.35\left(1+\frac{u_2}{160}\right)(e_w - e_a)$$

$$f_p = f_c + (f_0 - f_c)e^{-K_h t}$$

$$\text{PET} = \frac{AH_n + E_a\gamma}{A+\gamma}$$

$$P_{r,n} = {}^nC_r P^r q^{n-r}$$

$$= \frac{n!}{(n-r)!r!}P^r q^{n-r}$$

…8/-

Appendix

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

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z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	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	0.0910	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	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	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	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	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	0.3340	0.3365	0.3389
1.0	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	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	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	0.4370	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	0.4750	0.4756	0.4761	0.4767
2.0	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	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
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	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	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	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	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	0.4980	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	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	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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