UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 2073 / BFC 21103
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **FIVE (5)** QUESTIONS

THIS PAPER CONSISTS OF **FIFTEEN (15)** PAGES

Q1 (a) State :-

(i) Hydraulic radius
(ii) Hydraulic depth
(iii) Gradually varied flow
(iv) Non-uniform flow
(v) Sewerage.

(5 marks)

(b) Water flows uniformly at a depth of 1.35 m inside a circular cement channel with diameter of 2.42 m as shown in **Figure Q1**. If the channel has Manning's coefficient n of 0.012 and channel slope of 0.06°, calculate :-

(i) Flow rate, Q
(ii) Froude number and define the flow condition.

(10 marks)

(c) Referring to **Figure Q1**, if the excavation cost for the trench is RM 5/m^3, determine the cost to excavate the trench if the length is 15 m.

(5 marks)

Q2 (a) Water flows uniformly at 15 m^3/s in a trapezoidal channel with a base width of 3.5 m, sides slopes of 4.5 (H) : 1.5 (V) and channel slope of 1/5000. Chezy's coefficient, C is 50 m$^{0.5}$/s. Find the normal depth using graphical method.

(10 marks)

(b) According to **Q2 (a)** identify the conveyence factor, K for this channel.

(5 marks)

(c) If the channel in **Q2 (a)** is designed as the best effective section with sides slopes z is $1/\sqrt{3}$, prove that the top width water surface is equal to $4y\sqrt{3}/3$.

(5 marks)

Q3 (a) Define the following :-

(i) Hydraulic jump
(ii) Alternate depths.

(2 marks)

(b) A prismatic rectangular channel 2 m width carries water at a steady rate of 12 $m^3/s/m$ on a slope S_0 = 0.001 with Manning roughness coefficient n = 0.02. Broad-crested weir is constructed in the channel to control flow, find the minimum height of the weir, Δz.

(8 marks)

(c) A rectangular channel of width 7.2 m flows discharge at 20.53 m^3/s with a depth of 0.56 m. If the hydraulic jump occurred within the channel, determine :-

(i) Depth after the jump
(ii) Height of jump
(iii) Type of jump
(iv) Energy loss
(v) Power loss.

(10 marks)

Q4 (a) Briefly explain the difference between mild slope and steep slope.

(2 marks)

(b) Sketch the three types of flow profiles that flow on steep slope.

(3 marks)

(c) Water flows at a normal depth of 2.5 m in a trapezoidal channel. The channel has a bottom width of 5.5 m, side slope of 1(H):1(V), a bottom slope of 0.008 and Manning's coefficient n of 0.013. The channel ends with a free fall. If the channel length for gradually varied flow is between $0.98y_o$ and critical depth, determine :-

(i) Critical depth
(ii) Type of channel slope
(iii) Length of gradually varied flow profile using direct-integration method.

(15 marks)

Q5 (a) State **THREE (3)** types of hydraulic structure. How do you think this hydraulic structure can help in water resource management.

(5 marks)

(b) An 8 m length suppressed rectangular weir with 2.2 m high from bottom is constructed downstream of the 10 m wide channel. Calculate the discharge Q, from the weir if the height of water is 1.5 m as shown in **Figure Q5 (a).**

(5 marks)

(c) Water flows inside trapezoidal channel having sides slope angle 65°, channel slope 1:1500 and Manning's coefficient 0.012 as shown in **Figure Q5 (b).** A stepped-notch weir is placed inside the channel for discharge measurement purposes. The head over a stepped notch weir is shown in Figure Q5. If the coefficient of discharge is 0.65, calculate the discharge through the stepped notch weir.

(10 marks)

Q6 (a) Explain briefly :-

(i) Pelton turbine
(ii) Propeller pump

(4 marks)

(b) Briefly discuss on cavitation process occurrence in a pump.

(6 marks)

(c) A model study of a centrifugal pump gave the following characteristics :-

N = 1200 rev/min
Q = 0.91 m^3/min
H = 47 m
e = 85 %.

The diameter of the impeller was 50 cm. If a similar prototype of a diameter 0.8 m is to be designed, calculate :-

(i) The operational speed to deliver a flow of 0.1 m^3/s
(ii) Attainable head at the above flow rate
(iii) The power required to run the pump.

(10 marks)

S1 (a) Nyatakan maksud:-

(i) Jejari hidraulik
(ii) Ukurdalam hidraulik
(iii) Aliran berubah beransur
(iv) Aliran tak seragam
(v) Pembentung

(5 markah)

(b) Air mengalir seragam dengan ukur dalam 1.35 meter dalam sebuah saluran simen berbentuk bulat berdiameter 2.42 meter seperti ditunjukkan di dalam **Rajah S1**. Jika saluran ini mempunyai pekali Manning n 0.012 dan kecerunan saluran ialah 0.06°, kira :-

(i) Kadar alir, Q
(ii) Nombor Froude dan tentukan keadaan aliran.

(10 markah)

(c) Merujuk **Rajah S1**, jika kos untuk pengorekan lubang ialah RM 5/m^3, tentukan kos untuk mengorek lubang ini jika panjangnya ialah 15 m.

(5 markah)

S2 (a) Air mengalir secara seragam pada 15 m^3/s dalam saluran trapezoid dengan lebar bawah ialah 3.5 m, cerun tebing 4.5(H) : 1.5(V) dan kecerunan saluran 1/5000. Pekali Chezy, C ialah 50 m$^{0.5}$/s. Tentukan ukur dalam normal menggunakan kaedah grafik.

(10 markah)

(b) Berpandukan **S2 (a)** tentukan faktor hantaran bagi saluran ini.

(5 markah)

(c) Sekiranya saluran dalam **S2 (a)** direkabentuk sebagai keratan berkesan dengan cerun tebing z bersamaan dengan $1/\sqrt{3}$, buktikan bahawa lebar atas permukaan air T adalah bersamaan $4y\sqrt{3}/3$.

(5 markah)

S3 (a) Takrifkan berikut:

(i) Lompatan hidraulik
(ii) Kedalaman jodoh / berselang.

(2 markah)

(b) Sebuah saluran prismatik segiempat dengan 2 m lebar mengalirkan air pada kadar tetap 12 m^3/s di atas cerun $S_0 = 0.001$ dengan pekali kekasaran Manning $n = 0.02$. Sebuah empang dasar dibina untuk mengawal aliran, kira ketinggian minimum empang tersebut.

(8 markah)

(c) Aliran sebanyak 20.53 m^3/s mengalir di dalam sebuah saluran segiempat tepat yang mempunyai lebar 7.2 m pada kedalaman 0.56 m. Jika lompatan hidraulik terhasil, tentukan :-

(i) Kedalaman selepas lompatan
(ii) Tinggi lompatan
(iii) Jenis lompatan
(iv) Kehilangan tenaga
(v) Kehilangan kuasa.

(10 markah)

S4 (a) Berikan contoh kejadian profil aliran cerun curam.

(2 markah)

(b) Jelaskan dengan ringkas beza antara cerun landai dan cerun curam.

(3 markah)

(c) Air mengalir pada kedalaman normal 2.5 m di dalam saluran trapezoid. Keratan trapezoid memiliki lebar bawah bersamaan 5.5 m dan cerun sisi 1H: 1V. Saluran ini mempunyai cerun dasar S_0 iaitu 0.008, dan kekasaran pekali Manning n ialah 0.013. Saluran ini berakhir dengan jatuh bebas. Sekiranya panjang saluran bagi aliran berubah beransur di antara $0.98y_o$ dan ukurdalam genting tentukan :-

(i) Kedalaman genting, y_c
(ii) Jenis cerun saluran
(iii) Panjang profil bagi aliran berubah beransur dengan menggunakan kaedah kamiran terus.

(15 markah)

S5 (a) Nyatakan 3 jenis struktur hidraulik. Pada pendapat anda, bagaimana struktur hidraulik boleh membantu pengurusan sumber air.

(5 markah)

(b) Empang segiempat yang tidak digentingkan mempunyai 8 m panjang L, dan 2.2 m tinggi daripada dasar telah dibina di hilir saluran dengan lebar 5 m. Kira nilai aliran Q, jika tinggi aliran di puncak empang adalah 1.5 seperti ditunjukkan dalam **Rajah S5 (a)**.

(5 markah)

(c) Air mengalir di dalam saluran trapezoid dengan sudut cerun sisi 65°, cerun saluran 1:1500 dan pekali Manning 0.012 seperti ditunjukkan dalam **Rajah S5 (b)**. Sebuah sempak bertangga diletakkan di dalam saluran untuk tujuan pengukuran kadar alir. Turus air di atas sempak bertangga ditunjukkan di dalam Rajah S5. Jika pekali kadar alir ialah 0.65, kira kadar alir yang melalui sempak bertangga.

(10 markah)

S6 (a) Terangkan dengan ringkas :-

(i) Turbin pelton
(ii) Pam pemutar.

(4 markah)

(b) Bincangkan secara ringkas proses peronggaan berlaku di dalam pam.

(6 markah)

(c) Satu kajian model sebuah pam empar memperolehi ciri-ciri seperti berikut :-

N = 1200 pusingan/minit
Q = 0.91 m^3/min
H = 47 m
e = 85 %

Diameter pendesak ialah 50 cm. Jika pam prototaip berdiameter 0.8 m perlu direkabentuk, tentukan :-

(i) Kelajuan operasi untuk penghantaran 0.1 m^3/s aliran air,
(ii) Turus yang dapat dicapai pada kadar alir di atas,
(iii) Kuasa yang diperlukan untuk menggerakkan pam.

(10 markah)

APPENDIX I

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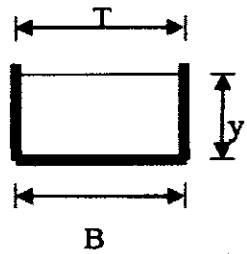
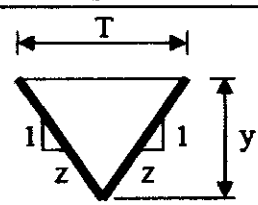
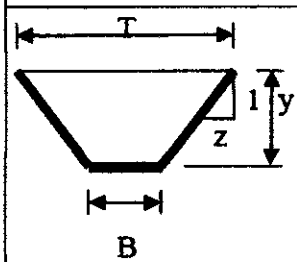
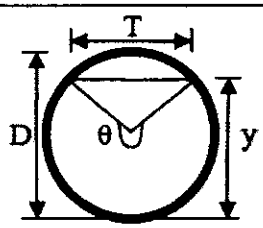
TABLE

Bentuk	A	T	P
	By	B	B + 2y
	zy^2	2zy	$2y\sqrt{1+z^2}$
	$By + zy^2$	B + 2zy	$B + 2y\sqrt{1+z^2}$
	$\frac{D^2}{8}(\theta - \sin\theta)$ θ dalam radian	$D(\sin\frac{\theta}{2})$ atau $2\sqrt{y(D-y)}$	$\frac{\theta D}{2}$ θ dalam radian

APPENDIX II

FINAL EXAMINATION

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Table Q4

α \ N	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
0.90	1.401	1.343	1.294	1.253	1.218	1.189	1.163	1.140	1.120	1.103
0.91	1.452	1.389	1.338	1.294	1.257	1.225	1.197	1.173	1.152	1.133
0.92	1.505	1.438	1.351	1.340	1.300	1.266	1.236	1.210	1.187	1.166
0.93	1.564	1.493	1.435	1.391	1.348	1.311	1.279	1.251	1.226	1.204
0.94	1.645	1.568	1.504	1.449	1.403	1.363	1.328	1.297	1.270	1.246
0.950	1.737	1.652	1.582	1.518	1.467	1.423	1.385	1.352	1.322	1.296
0.960	1.833	1.741	1.665	1.601	1.545	1.497	1.454	1.417	1.385	1.355
0.970	1.969	1.866	1.780	1.707	1.644	1.590	1.543	1.501	1.464	1.431
0.975	2.055	1.945	1.853	1.773	1.707	1.649	1.596	1.554	1.514	1.479
0.980	2.164	2.045	1.946	1.855	1.783	1.720	1.666	1.617	1.575	1.536
0.985	2.294	2.165	2.056	1.959	1.880	1.812	1.752	1.699	1.652	1.610
0.990	2.477	2.333	2.212	2.106	2.017	1.940	1.873	1.814	1.761	1.714
0.995	2.792	2.621	2.478	2.355	2.250	2.159	2.070	2.008	1.945	1.889
0.999	3.523	3.292	3.097	2.931	2.788	2.663	2.554	2.457	2.370	2.293
1.000	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
1.001	3.317	2.931	2.640	2.399	2.184	2.008	1.856	1.725	1.610	1.508
1.005	2.587	2.286	2.022	1.818	1.679	1.506	1.384	1.279	1.188	1.107
1.010	2.273	1.977	1.757	1.572	1.419	1.291	1.182	1.089	1.007	0.936
1.015	2.090	1.807	1.602	1.428	1.286	1.166	1.065	0.978	0.902	0.836
1.020	1.961	1.711	1.493	1.327	1.191	1.078	0.982	0.900	0.828	0.766
1.03	1.779	1.531	1.340	1.186	1.060	0.955	0.866	0.790	0.725	0.668
1.04	1.651	1.410	1.232	1.086	0.967	0.868	0.785	0.714	0.653	0.600
1.05	1.552	1.334	1.150	1.010	0.896	0.802	0.723	0.656	0.598	0.548
1.06	1.472	1.250	1.082	0.948	0.838	0.748	0.672	0.606	0.553	0.506
1.07	1.404	1.196	1.026	0.896	0.790	0.703	0.630	0.569	0.516	0.471
1.08	1.346	1.139	0.978	0.851	0.749	0.665	0.595	0.535	0.485	0.441
1.09	1.295	1.089	0.935	0.812	0.713	0.631	0.563	0.506	0.457	0.415
1.10	1.250	1.050	0.897	0.777	0.681	0.601	0.536	0.480	0.433	0.392
1.11	1.209	1.014	0.864	0.746	0.652	0.575	0.511	0.457	0.411	0.372
1.12	1.172	0.981	0.833	0.718	0.626	0.551	0.488	0.436	0.392	0.354
1.13	1.138	0.950	0.805	0.692	0.602	0.529	0.468	0.417	0.374	0.337
1.14	1.107	0.921	0.780	0.669	0.581	0.509	0.450	0.400	0.358	0.322
1.15	1.078	0.892	0.756	0.647	0.561	0.490	0.432	0.384	0.343	0.308
1.16	1.052	0.870	0.734	0.627	0.542	0.473	0.417	0.369	0.329	0.295
1.17	1.027	0.850	0.713	0.608	0.525	0.458	0.402	0.356	0.317	0.283
1.18	1.003	0.825	0.694	0.591	0.509	0.443	0.388	0.343	0.305	0.272
1.19	0.981	0.810	0.676	0.574	0.494	0.429	0.375	0.331	0.294	0.262
1.20	0.960	0.787	0.659	0.559	0.480	0.416	0.363	0.320	0.283	0.252
1.22	0.922	0.755	0.628	0.531	0.454	0.392	0.341	0.299	0.264	0.235
1.24	0.887	0.725	0.600	0.505	0.431	0.371	0.322	0.281	0.248	0.219

APPENDIX III

FINAL EXAMINATION

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Table Q4

s \ N	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.26	0.655	0.602	0.574	0.482	0.410	0.351	0.304	0.265	0.233	0.205
1.28	0.627	0.606	0.551	0.461	0.391	0.334	0.288	0.250	0.219	0.193
1.30	0.600	0.644	0.530	0.442	0.373	0.318	0.274	0.237	0.207	0.181
1.32	0.775	0.625	0.510	0.424	0.357	0.304	0.260	0.225	0.196	0.171
1.34	0.752	0.605	0.492	0.406	0.342	0.290	0.248	0.214	0.185	0.162
1.36	0.731	0.588	0.475	0.393	0.329	0.278	0.237	0.204	0.176	0.153
1.38	0.711	0.567	0.459	0.378	0.316	0.266	0.226	0.194	0.167	0.145
1.40	0.692	0.548	0.444	0.365	0.304	0.256	0.217	0.185	0.159	0.138
1.42	0.674	0.533	0.431	0.353	0.293	0.246	0.208	0.177	0.152	0.131
1.44	0.658	0.517	0.417	0.341	0.282	0.236	0.199	0.169	0.145	0.125
1.46	0.642	0.505	0.405	0.330	0.273	0.227	0.191	0.162	0.139	0.119
1.48	0.627	0.493	0.394	0.320	0.263	0.219	0.184	0.156	0.133	0.113
1.50	0.613	0.480	0.383	0.310	0.255	0.211	0.177	0.149	0.127	0.106
1.55	0.580	0.451	0.358	0.288	0.235	0.194	0.161	0.135	0.114	0.097
1.60	0.551	0.425	0.335	0.269	0.218	0.179	0.148	0.123	0.103	0.087
1.65	0.525	0.402	0.316	0.251	0.203	0.165	0.136	0.113	0.094	0.079
1.70	0.501	0.381	0.298	0.236	0.189	0.153	0.125	0.103	0.086	0.072
1.75	0.480	0.362	0.282	0.222	0.177	0.143	0.116	0.095	0.079	0.065
1.80	0.460	0.349	0.267	0.209	0.166	0.133	0.108	0.088	0.072	0.060
1.85	0.442	0.332	0.254	0.198	0.156	0.125	0.100	0.082	0.067	0.055
1.90	0.425	0.315	0.242	0.188	0.147	0.117	0.094	0.076	0.062	0.050
1.95	0.409	0.304	0.231	0.178	0.139	0.110	0.088	0.070	0.057	0.046
2.00	0.395	0.292	0.221	0.169	0.132	0.104	0.082	0.066	0.053	0.043
2.10	0.369	0.273	0.202	0.154	0.119	0.092	0.073	0.058	0.046	0.037
2.20	0.346	0.253	0.186	0.141	0.107	0.083	0.065	0.051	0.040	0.032
2.3	0.326	0.236	0.173	0.129	0.096	0.075	0.056	0.045	0.035	0.028
2.4	0.308	0.220	0.160	0.119	0.089	0.068	0.052	0.040	0.031	0.024
2.5	0.292	0.207	0.150	0.110	0.082	0.062	0.047	0.036	0.028	0.022
2.6	0.277	0.197	0.140	0.102	0.076	0.057	0.043	0.033	0.025	0.019
2.7	0.264	0.188	0.131	0.095	0.070	0.052	0.039	0.029	0.022	0.017
2.8	0.252	0.176	0.124	0.089	0.065	0.048	0.036	0.027	0.020	0.015
2.9	0.241	0.166	0.117	0.083	0.060	0.044	0.033	0.024	0.018	0.014
3.0	0.230	0.159	0.110	0.078	0.056	0.041	0.030	0.022	0.017	0.012
3.5	0.190	0.126	0.085	0.059	0.041	0.029	0.021	0.015	0.011	0.008
4.0	0.161	0.104	0.069	0.046	0.031	0.022	0.015	0.010	0.007	0.005
4.5	0.139	0.087	0.057	0.037	0.025	0.017	0.011	0.008	0.005	0.004
5.0	0.122	0.076	0.048	0.031	0.020	0.013	0.009	0.006	0.004	0.003
6.0	0.098	0.060	0.036	0.022	0.014	0.009	0.006	0.004	0.002	0.002
7.0	0.081	0.048	0.028	0.017	0.010	0.006	0.004	0.002	0.002	0.001
8.0	0.069	0.040	0.022	0.013	0.008	0.005	0.003	0.002	0.001	0.001
9.0	0.060	0.034	0.019	0.011	0.006	0.004	0.002	0.001	0.001	0.000
10.0	0.053	0.029	0.016	0.009	0.005	0.003	0.002	0.001	0.001	0.000
20.0	0.023	0.013	0.011	0.006	0.002	0.001	0.001	0.000	0.000	0.000

APPENDIX IV

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FIGURE

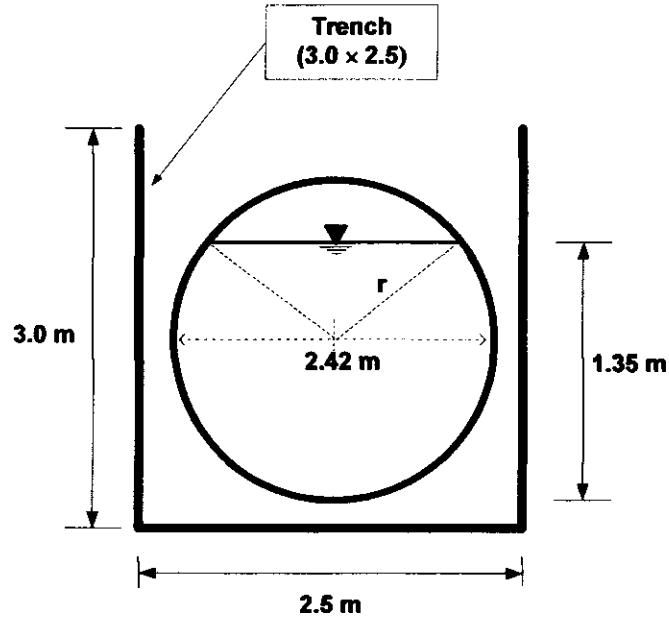

Figure Q1

APPENDIX V

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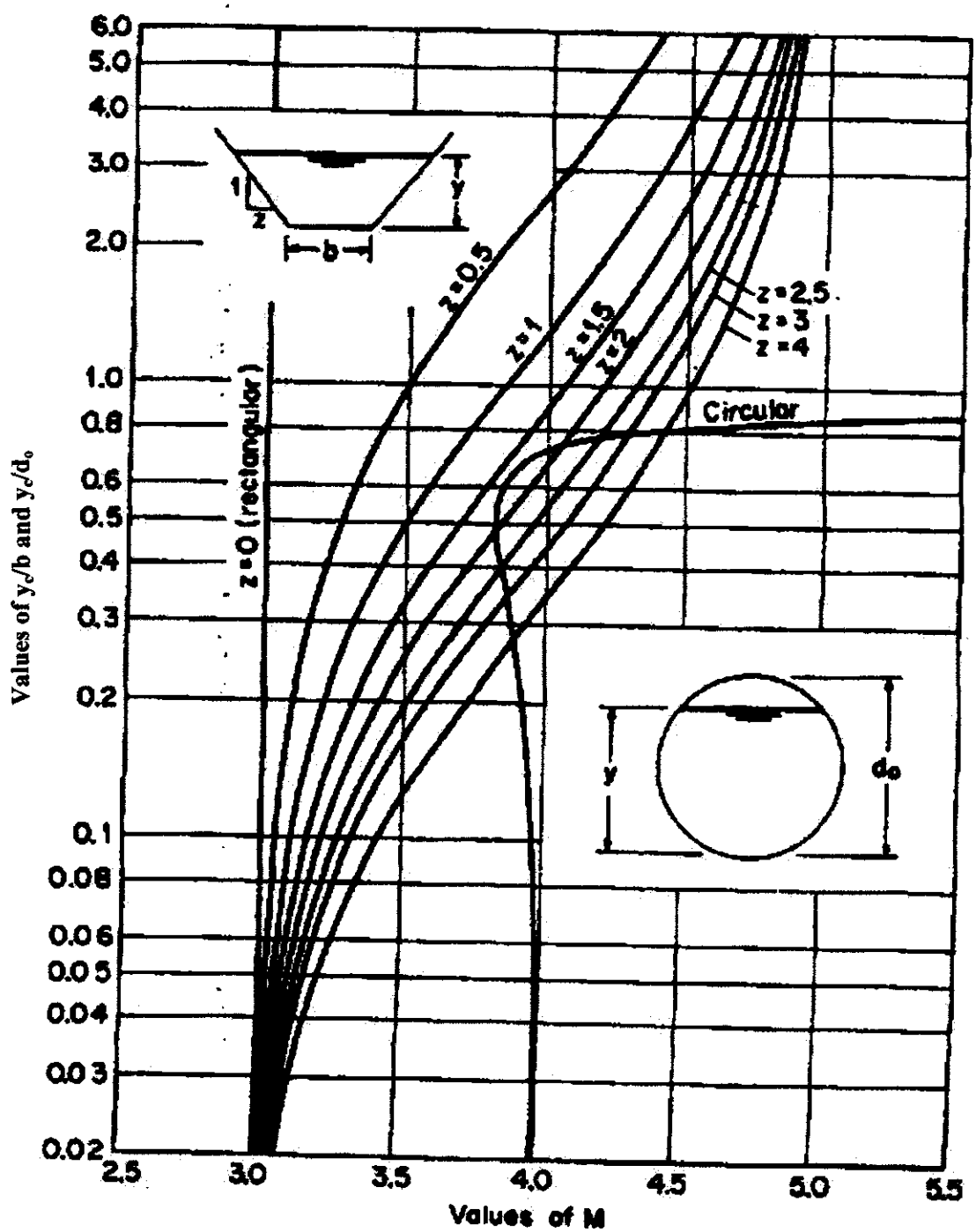

Figure Q4 (a) : M value curve

APPENDIX VI

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2010/2011 PROGRAMME : 2 BFF
COURSE NAME : HYDRAULICS COURSE CODE : BFC 2073 / BFC 21103

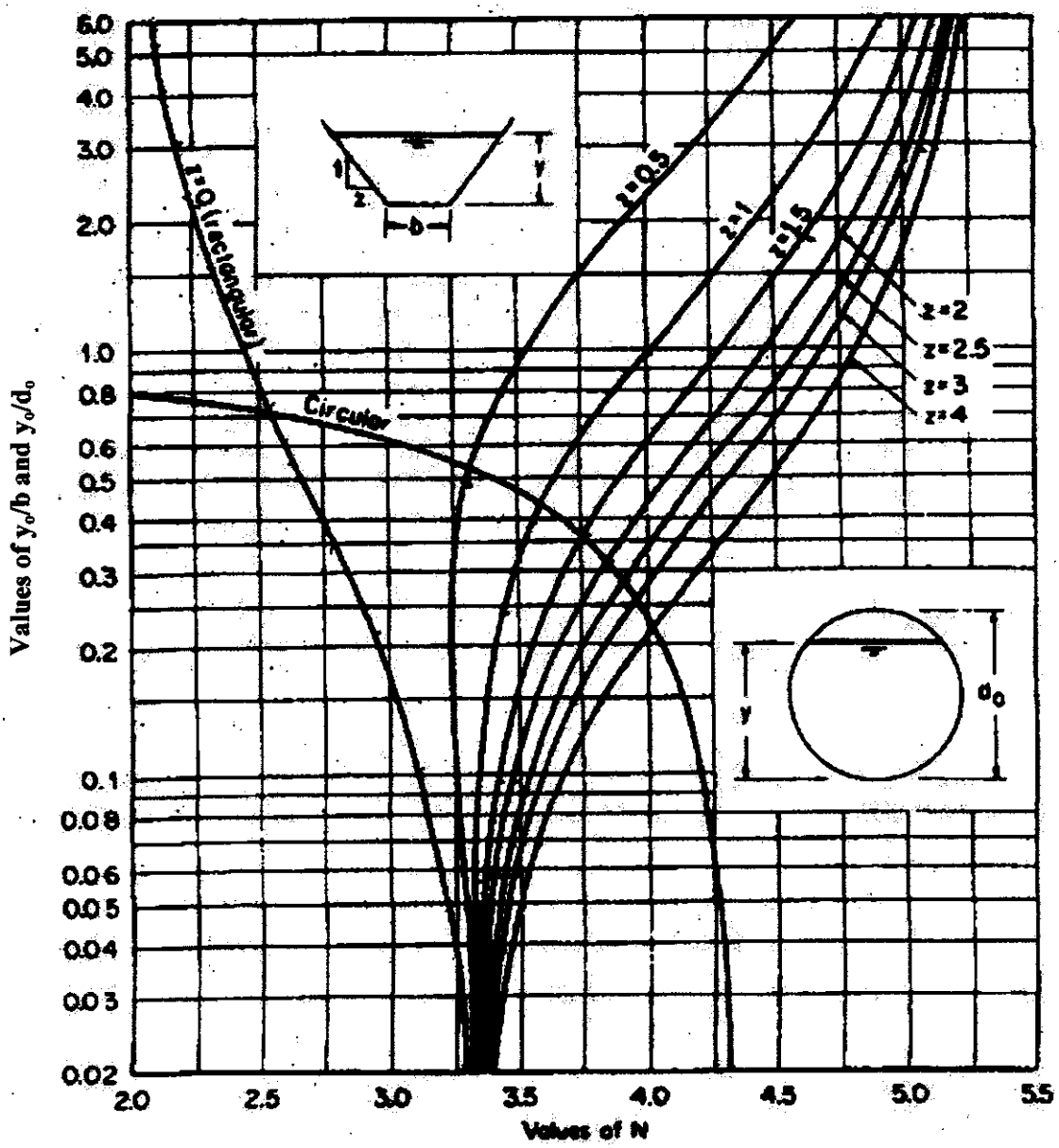

Figure Q4 (b) : N value curve

APPENDIX VII

FINAL EXAMINATION

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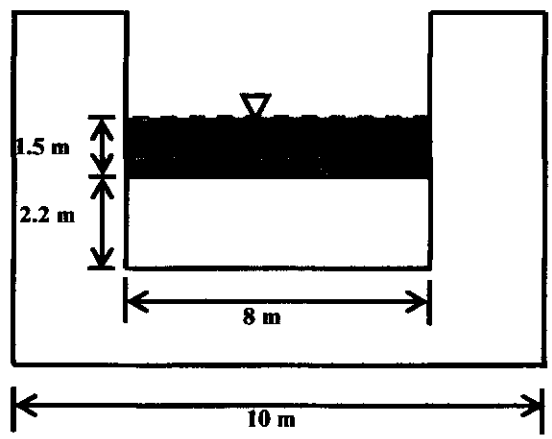

Figure Q5 (a)

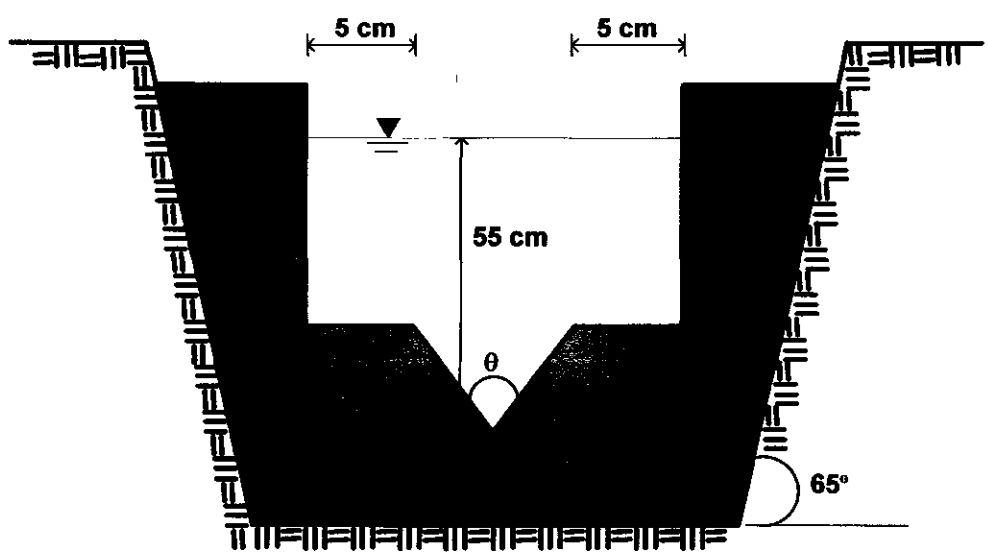

Figure Q5 (b)

APPENDIX VIII

FINAL EXAMINATION

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EQUATIONS

$$Q = \frac{8}{15} C_d \sqrt{2g} \tan\theta \, H_1^{5/2} \qquad Q = \frac{2}{3} C_d B \sqrt{2g} \, L_e H_1^{3/2} \qquad L_e = L - (0.1nH_1)$$

$$A = \frac{D^2}{8}(\theta - \sin\theta) \qquad P = r\theta \qquad T = 2\sqrt{y(D-y)} \qquad Fr = \frac{v}{\sqrt{gD}}$$

$$Q = \frac{1}{n} A R^{2/3} \sqrt{S_o} \qquad Cd = 0.611 + 0.075\left(\frac{H_1}{P}\right) \qquad E = y + \frac{q^2}{2gy^2}$$

$$H_{min} = E_o - E_{min} \qquad Q = \frac{1}{n} A R^{2/3} \sqrt{S_o} \qquad Q = \frac{K}{\sqrt{S_o}}$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8Fr_1^2}\right) \qquad \Delta E = \frac{(y_2 - y_1)^3}{4y_1 y_2} \qquad Fr_1^{\,2} = \frac{q^2}{g y_1^{\,3}}$$

$$P_L = \rho g Q E_L \qquad u_1 = \frac{y_1}{y_o} \qquad u_2 = \frac{y_2}{y_o} \qquad v_1 = u_1^{\,N/J}$$

$$v_2 = u_2^{\,N/J} \qquad J = \frac{N}{N - M + 1} \qquad y_c = \sqrt[3]{\frac{q^2}{g}} \qquad P_i = \rho Q(u_d V_{ud} - u_s V_{us})$$

$$L = x_2 - x_1 = \frac{y_o}{S_o}\left\{\left[(u_2 - u_1) - \{F(u_2, N) - F(u_1, N)\} + \left(\frac{y_c}{y_o}\right)^M \left(\frac{J}{N}\right)\{F(v_2, J) - F(v_1, J)\}\right]\right\}$$

$$Q = \frac{2}{3} C_d L H^{3/2} \sqrt{2g} \qquad \frac{H_m}{D^2{}_m N^2{}_m} = \frac{H_p}{D^2{}_p N^2{}_p} \qquad \frac{P_m}{\gamma D^5{}_m N^3{}_m} = \frac{P_p}{\lambda D^5{}_p N^3{}_p}$$

$$\frac{Q_m}{N_m D^3{}_m} = \frac{Q_p}{N_p D^3{}_p} \qquad \frac{N_m \sqrt{Q_m}}{H_m^{\,3/4}} = \frac{N_p \sqrt{Q_p}}{H_p^{\,3/4}} \qquad \eta = \frac{P_o}{P_i} \qquad P_o = \gamma Q H$$

$$\frac{A_c^{\,3}}{T_c} = \frac{Q^2}{g}$$