UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT NAME	:	HYDRAULIC
SUBJECT CODE	:	BFC 2073
COURSE	:	2 BFF
EXAMINATION DATE	:	APRIL 2010
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) Time and space are the main criteria used in classifying types of flow. Explain both criteria with an example respectively.

(6 marks)

(b) Define the velocity and flow rate in a trapezoidal section with the gradient 0.002, width of 4 m, side slope, z = 2 and 2.2 m depth. Given 'Kutter' coefficient, n is 0.013.

$$\text{Given : } C = \frac{23 + \frac{0.00155}{S_o} + \frac{1}{n}}{1 + \frac{n}{\sqrt{R}}\left[23 + \frac{0.00155}{S_o}\right]}$$

(7 marks)

(c) A concrete trapezoidal channel with Manning *n* value of 0.023 carrying a flow of 25 m^3/s. The channel has a bottom slope of S_o = 0.0013. Determine the effective hydraulic section if *z* is 3 (horizontal) : 1 (vertical).

(12 marks)

Q2 (a) Explain the condition of critical flow in non uniform flow.

(2 marks)

(b) A rectangular channel, 5 m, carrying a discharge of 50 m^3/s;

(i) Tabulate depth of flow against specific energy for depth from 1 m to 6 m.

(ii) Calculate the minimum specific energy.

(iii) What types of flow exist when depths are 0.5 m and 4 m?

(iv) For C = 120, what slopes are necessary to maintain the depths in (b) (iii).

(10 marks)

(c) A rectangular channel, 4.2 m wide, carries a flow of 22 m^3/s. At a particular channel location immediately the channel slope changes from 0.02 to 0.001. Determine whether a hydraulic jump would occur and hence determine also the position of the jump and the energy dissipated during the jump. Given n = 0.013.

(13 marks)

Q3 (a) In order to derive a basic equation for a gradually varied flow, a number of assumptions have to be made. Briefly explain three of those assumptions.

(6 marks)

(b) A very wide canal (Figure Q3) with a Manning's coefficient, n = 0.015 and a bed slope of 1:1000 is having a flow with a normal depth of 1.20 m. A weir is built at the downstream end which raises the water depth to 2.40 m behind the structure. Determine:

(i) The flow rate per meter width and the critical depth of the flow.

(ii) The type of flow profile.

(iii) The distance, L using the Direct Integration Method.

(19 marks)

Q4 (a) Define Undistorted and Distorted Model.

(2 marks)

(b) Explain briefly geometry, kinematics and dynamic similarity.

(6 marks)

(c) The equation of resistance force, F on a ship is a function of the body size (expressed via a characteristic length, L), fluid velocity, V, gravity, g and density of fluid, ρ and dynamic viscosity, μ. Obtain an expression in dimensionless equation for the resistance force (F) by using Pi Buckingham theorem.

Given : $F = fn (L, V, g, \rho, \mu)$ and repeating variables : L, g and μ

(17 marks)

Q5 (a) Name 3 (three) types of pumps and 3 (three) types of turbines.

(6 marks)

(a) Using the aid of sketches, explain the concept of series and parallel pump.

(7 marks)

(b) A reaction turbine 1.5 m in diameter, when running at 200 rpm, developed brake power of 500 kW when the flow was 0.8 m^3/s. The pressure head at the entrance to the turbine was 30 m and the elevation of the turbine casing above tailwater level was 1.90 m. The water enters the turbine with a velocity of 4.1 m/s. Calculate:

(i) the effective head, H

(ii) the overall efficiency.

(iii) the speed expected under a head of 60 m.

(iv) the brake power and discharge under the 60 m head.

(12 marks)

S1 (a) Masa dan ruang merupakan dua kriteria utama yang digunakan untuk mengkelaskan jenis- jenis aliran. Terangkan kedua-dua kriteria tersebut berserta satu contoh masing- masing.

(6 markah)

(b) Tentukan halaju dan kadar alir di dalam sebuah saluran trapezoid yang mempunyai kecerunan dasar saluran 0.002, lebar 4 m, cerun sisi, z = 2 dan ukur dalam aliran 2.2 m. Diberi pekali kekasaran 'Kutter', *n* ialah 0.013.

$$\text{Diberi : } C = \frac{23 + \dfrac{0.00155}{S_o} + \dfrac{1}{n}}{1 + \dfrac{n}{\sqrt{R}}\left[23 + \dfrac{0.00155}{S_o}\right]}$$

(7 markah)

(c) Sebuah terusan konkrit berbentuk trapezoid dengan nilai Manning, *n* ialah 0.023 membawa aliran sebanyak 25 m^3/s. Terusan mempunyai cerun dasar, S_o = 0.0013. Tentukan saiz saluran paling berkesan jika nisbah cerun sisi, z ialah 3 (ufuk) : 1 (tegak).

(12 markah)

S2 (a) Terangkan keadaan bagi aliran genting dalam aliran tidak seragam.

(2 markah)

(b) Sebuah saluran segiempat tepat, 5 m membawa aliran 50 m^3/s;

(i) Dapatkan kedalaman aliran melawan tenaga tentu bagi kedalaman daripada 1 m sehingga 6 m.

(ii) Kirakan tenaga tentu minimum.

(iii) Apakah jenis aliran yang wujud apabila kedalaman ialah 0.5 m dan 4 m?

(iv) Bagi C = 120, apakah kecerunan yang diperlukan bagi mengekalkan kedalaman di (b)(iii).

(10 markah)

(c) Sebuah saluran segiempat bersaiz 4.2 m lebar membawa aliran pada kadar 22 m^3/s. Pada suatu lokasi saluran ini terdapat perubahan cerun secara mendadak dari 0.02 kepada 0.001. Kenalpasti sama ada lompatan hidraulik akan berlaku seterusnya tentukan kedudukan lompatan dan tenaga yang terlesap semasa lompatan. Diberi n = 0.013.

(13 markah)

S3 (a) Untuk menerbitkan persamaan asas untuk aliran berubah secara beransur, beberapa andaian boleh dibuat. Terangkan tiga daripada andaian-andaian tersebut.

(6 markah)

(b) Sebuah terusan yang sangat lebar dengan pekali Manning $n = 0.015$ dan kecerunan dasar 1:1000 mengalirkan air pada ukurdalam normal 1.20 m. Sebuah empang dasar dibina pada satu titik untuk meninggikan ukurdalam aliran di hulu empangan kepada 2.40 m di belakang empang. Tentukan;

(i) Kadaralir per meter lebar dan kedalaman genting aliran.

(ii) Jenis susuk aliran.

(iii) Jarak, L dengan menggunakan Kaedah Kamiran Terus.

(19 markah)

S4 (a) Definisi model Tak Terherot dan Terherot.

(2 markah)

(b) Terangkan secara ringkas tentang keserupaan geometri, keserupaan kinematik dan keserupaan dinamik.

(6 markah)

(c) Persamaan bagi daya rintang F pada sebuah kapal bergantung kepada saiz kapal (diungkapkan melalui panjang kapal, L), halaju, V, pecutan graviti, g dan sifat bendalir iaitu ketumpatan bendalir, ρ dan kelikatan dinamik, μ. Terbitkan persamaan tak berdimensi bagi daya rintang (F) dengan menggunakan Theorem Buckingham Pi. Diberi: $F = fn\ (L, V, g, \rho, \mu)$ dan pembolehubah berulang : L, g dan μ.

(17 markah)

S5 (a) Namakan tiga (3) jenis pam dan tiga (3) jenis turbin.

(6 markah)

(b) Dengan bantuan gambarajah, terangkan konsep pam bersiri dan selari.

(7 markah)

(b) Sebuah turbin yang bergaris pusat 1.5 m, menghasilkan kuasa sebanyak 200 kW apabila kelajuan dan kadar alir masing-masing ialah 500 rpm dan 0.8 m^3/s. Turus tekanan di bahagian masuk turbin ialah 30 m dan aras selongsong turbin teletak 1.90 m di atas aras air. Diberi air memasuki turbin bergerak dengan halaju 4.1 m/s. Kirakan

(i) Turus berkesan, H

(ii) Kecekapan keseluruhan

(iii) Kelajuan yang dijangkakan di bawah turus 60 m

(iv) Kuasa dan kadaralir di bawah turus 60 m

(12 markah)

APPENDIX 1

FINAL EXAMINATION

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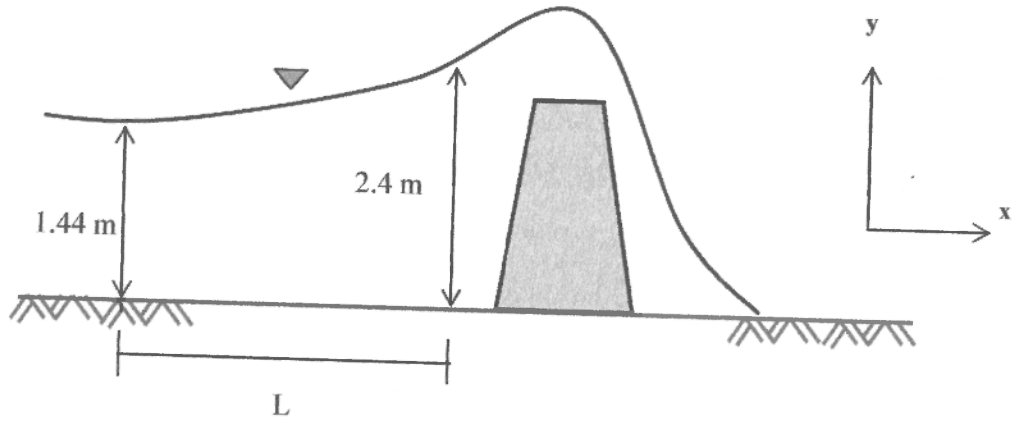

Figure O3

APPENDIX 2

FINAL EXAMINATION

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Table 1: Quantity for Fluid Mechanics with Dimensional

Kuantiti	Quantity	Symbol	Dimension
ASAS	**FUNDAMENTAL**		
Jisim	Mass	m	M
Panjang	Length	L	L
Masa	Time	t	T
GEOMETRI	**GEOMETRIC**		
Luas	Area	A	L^2
Isipadu	Volume	V	L^3
Sudut	Angle	θ	$M^0L^0T^0$
Momen luas pertama	First area moment	Ax	L^3
Momen luar kedua	Second area moment	Ax^2	L^4
Keterikan	Strain	e	L^0
DINAMIK	**DINAMIC**		
Daya	Force	F	MLT^{-2}
Berat	Weight	W	MLT^{-2}
Berat tentu	Specific weight	γ	$ML^{-2}T^{-2}$
Ketumpatan	Density	ρ	ML^{-3}
Tekanan	Pressure	P	$ML^{-1}T^{-2}$
Tegasan ricih	Shear stress	τ	$ML^{-1}T^{-2}$
Modulus keanjalan	Modulus of elasticity	E, K	$ML^{-1}T^{-2}$
Momentum	Momentum	M	MLT^{-1}
Momentum sudut	Angular momentum		ML^2T^{-1}
Momen momentum	Moment of momentum		ML^2T^{-1}
Momen daya	Force moment	T	ML^2T^{-2}
Daya kilas	Torque	T	ML^2T^{-2}
Tenaga	Energy	E	L
Kerja	Work	W	ML^2T^{-2}
Kuasa	Power	P	ML^2T^{-3}
Kelikatan dinamik	Dynamic viscocity	μ	$ML^{-1}T^{-1}$
Tegangan permukaan	Surface tension	σ	MT^{-2}
KINEMATIK	**KINEMATIC**		
Halaju lelurus	Linear velocity	U,v,u	LT^{-1}
Halaju sudut	Angular velocity	ω	T^{-1}
Halaju putaran	Rotational speed	N	T^{-1}
Pecutan	Acceleration	a	LT^{-2}
Pecutan sudut	Angular acceleration	α	T^{-2}
Graviti	Gravity	g	LT^{-2}
Kadar alir	Discharge	Q	L^3T^{-1}
Kelikatan kinematik	Kinematic viscosity	υ	L^2T^{-1}
Fungsi arus	Stream function	ψ	L^2T^{-1}
Putaran	Circulation	Γ	L^2T^{-1}
Pusaran	Vorticity	Ω	T^{-1}

APPENDIX 3

FINAL EXAMINATION

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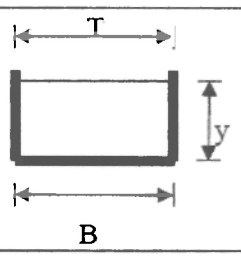
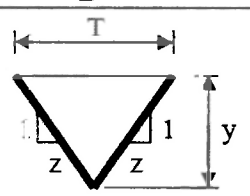
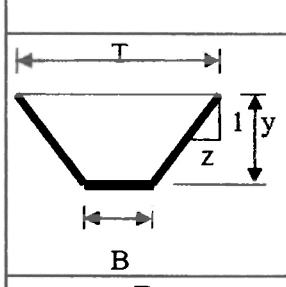
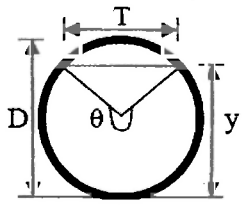
Table 2: Type of geometry in Open Channel

Shape	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 4

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Table 3(b): Value of F(u,N)

u \ 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	1.598	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	2.266	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	0.608	0.553	0.506
1.07	1.404	1.195	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 5

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Table 3(b): Value of F(u,N)

u \ N	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.26	0.855	0.692	0.574	0.482	0.410	0.351	0.304	0.265	0.233	0.206
1.28	0.827	0.666	0.551	0.461	0.391	0.334	0.288	0.250	0.219	0.193
1.30	0.800	0.644	0.530	0.442	0.373	0.318	0.274	0.237	0.207	0.181
1.32	0.776	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	0.408	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	0.108
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	0.348	0.253	0.186	0.141	0.107	0.083	0.065	0.051	0.040	0.032
2.3	0.326	0.235	0.173	0.129	0.098	0.075	0.058	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	0.181	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	0.058	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	0.028	0.016	0.009	0.005	0.003	0.002	0.001	0.001	0.000
20.0	0.023	0.018	0.011	0.006	0.002	0.001	0.001	0.000	0.000	0.000

APPENDIX 6

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2009/2010 COURSE : 2 BFF
SUBJECT : HYDRAULIC SUBJECT CODE : BFC 2073

EQUATIONS

$$Q = \frac{1}{n} A R^{2/3} \sqrt{S_o} \qquad Q = AC\sqrt{RS_C} \qquad \frac{y_2}{y_1} = \frac{1}{2}\left[\left(\sqrt{1 + 8Fr_1^{\,2}}\right) - 1\right]$$

$$E = y + \frac{1}{2g}\left(\frac{Q}{A}\right)^2 \qquad F_{r1}^{\,2} = \frac{q^2}{g y_1^{\,3}} \qquad P = \rho g Q E_L \qquad E_L = \frac{(y_2 - y_1)^3}{4 y_1 y_2}$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} \qquad \Delta x = \frac{\Delta y}{S_o}\left[\frac{1 - \left(\frac{y_c}{y_{ave}}\right)^3}{1 - \left(\frac{y_o}{y_{ave}}\right)^3}\right] \qquad \Delta x = \frac{\Delta y}{S_o}\left[\frac{1 - \left(\frac{y_c}{y_{ave}}\right)^3}{1 - \left(\frac{y_o}{y_{ave}}\right)^{10/3}}\right]$$

$$v = u^{N/J} \qquad J = N/N - M + 1 \qquad u = y / y_o$$

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

$$P_o = \rho g H Q \qquad P = \eta_0 \gamma Q H \qquad \left(\frac{Q}{ND^3}\right)_1 = \left(\frac{Q}{ND^3}\right)_2 \qquad \left(\frac{H}{N^2D^2}\right)_1 = \left(\frac{H}{N^2D^2}\right)_2$$

$$\left(\frac{P}{N^3D^5}\right)_1 = \left(\frac{P}{N^3D^5}\right)_2 \qquad \left(\frac{NQ^{1/2}}{H^{3/4}}\right)_1 = \left(\frac{NQ^{1/2}}{H^{3/4}}\right)_2 \qquad \frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$