UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESI 2009/2010

NAME OF COURSE	:	HYDRAULICS
CODE OF COURSE	:	BFC 2073
PROGRAMME	:	2 BFC
DURATION	:	3 HOURS
DATE OF EXAM	:	NOVEMBER 2009
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS FROM **SIX (6)** QUESTIONS

THIS PAPER CONSISTS **NINE (9)** PAGES

Q1. (a) Explain briefly, what is meant by an open channel?

(2 marks)

(b) For a given cross sectional area, show that the best dimensions for a trapezoidal channel is when

$$R = y/2$$

where R is hydraulic radius of the channel and y is the depth of flow.

(8 marks)

(c) Determine the most efficient section of a trapezoidal channel with n = 0.025 and to carry 12.75 m3/s of water. The maximum velocity is to be 920 mm/s and side slopes of trapezoidal channel are 1 vertical and 2 horizontal to prevent scouring. Under such condition, what bed slope S of channel is required.

(10 marks)

Q2. (a) Derive an expression for the maximum unit flow q_{max} in a rectangular channel for a given specific energy E.

(4 marks)

(b) Develop the expression for critical depth, critical specific energy and critical velocity for a rectangular channel for any channel shapes.

(10 marks)

(c) A rectangular channel of a width of 3.66 m carries 5.66 m^3/s of water. Find the critical depth y_c and the critical velocity V_c . What is the slope of the channel if the n value is 0.02.

(6 marks)

Q3. (a) Using momentum principle prove that the relation between the depth before and after hydraulic jump of a rectangular channel is;

$$y_c = \frac{1}{2} y_1 y_2 (y_1 + y_2)$$

where,

y_c = critical depth
y_1 = depth before the jump
y_2 = depth after the jump

(10 marks)

(b) A rectangular channel 6.1 m wide, carries 11.32 m^3/s of water and discharge into a 6.1 m wide concrete apron with no slope and with mean velocity of 6.1 m. What is the height of the jump and the energy dissipated in the jump?

(10 marks)

Q4. (a) Explain briefly two(2) types of surface profile that could occur when water flows in an adverse slope channel.

(4 marks)

(b) A rectangular channel with 90 m width, n = 0.025 and 0.0006 bottom slope used to flow the water in 3 m normal depth. When the weir structure is install at the downstream, the flow profile changing at downstream and increase 6% from normal depth. Determine the surface water profile by using Direct Step Method, (All calculation must be done in Table 2 at Appendix 2 in 3 steps and attach in the answering book sheet).

(16 marks)

Q5. (a) State (only two) the significance of dimensional analysis engineering field.

(2 marks)

(b) The discharge of a spillways model with a scale of 1:50 is 1.25 m^3/s, find the discharge of prototype? If flood scenario takes only 12 hours in prototype, how long should it take in the model?

(6 marks)

(c) Show that

$$\frac{F}{\rho V^2 L^2} = \text{fn}\left[\frac{gL}{V^2}, \frac{\mu}{\rho V L}\right]$$

When the resistance force, F of ship is a function of its length, L, velocity, V, acceleration due to gravity, g, and fluid properties like density ρ dan viscosity, μ.

(12 marks)

Q6. (a) Explain briefly with a sketch of diagram a pump system operating in series and parallel.

(6 marks)

(b) Two homologous pumps A and B are able to operate at the same speed of 600 rpm. Pump A has an impeller of 50 cm diameter and water discharge of 0.4 m^3/s under a net head of 50 m. Determine the size of impeller and net head of pump B if the discharge is 0.3 m^3/s.

(7 marks)

(c) Given the power of a turbine is 8500 kW at 150 rpm and the head is 20 m. Calculate the power of the turbine if the head decrease to 10 m.

(7 marks)

S1. (a) Terangkan dengan ringkas, apakah yang dimaksudkan dengan saluran terbuka.

(2 markah)

(b) Bagi suatu luas keratan tertentu, tunjukkan bahawa keratan paling berkesan untuk saluran berbentuk trapezium apabila

$$R = y/2$$

dimana R ialah jejari hidraulik dan y ialah kedalaman aliran.

(8 markah)

(c) Tentukan keratan paling berkesan bagi saluran berbentuk trapezium dimana nilai pekali kekasaran n ialah 0.025 untuk menampung 12.75 m^3/s kadar alir. Halaju maksimum ditetapkan pada 920 mm/s dan kecerunan tebing saluran trapezium ialah 1 menegak dan 2 mendatar untuk menghindarkan hakisan. Kira nilai kecerunan dasar, S yang diperlukan bagi kes diatas.

(10 markah)

S2. (a) Terbitkan satu ungkapan bagi aliran unit maksimum q_{maks} dalam saluran segiempat bagi suatu nilai tenaga tentu E.

(4 markah)

(b) Terbitkan ungkapan bagi kedalaman genting, tenaga tentu genting dan halaju genting bagi saluran segiempat dan saluran sebarang bentuk.

(10 markah)

(c) Saluran segiempat mengalirkan 5.66 m^3/s air. Kirakan kedalaman genting y_c dan halaju genting V_c untuk saluran yang 3.66 m lebar. Apakah kecerunan saluran yang akan terhasil jika nilai n ialah 0.02.

(6 markah)

S3. (a) Dengan menggunakan prinsip momentum buktikan hubungan kedalaman sebelum dan selepas lompatan hidraulik untuk saluran segi empat adalah;

$$y_c = \frac{1}{2} y_1 y_2 (y_1 + y_2)$$

dimana,

y_c = kedalaman genting
y_1 = kedalaman sebelum lompatan
y_2 = kedalaman selepas lompatan

(10 markah)

(b) Sebuah saluran segiempat dengan 6.1 m lebar, membawa 11.32 m^3/s air dan melepaskan aliran tersebut ke lantai konkrit dengan 6.1 m lebar dan halaju sebanyak 6.1 m. Kira ketinggian lompatan dan tenaga yang dilesapkan semasa lompatan.

(10 marks)

S4. (a) Terangkan dengan ringkas 2 jenis susuk (profil) aliran ketika mengalir di dalam saluran yang berkecerunan melawan.

(4 markah)

(b) Sebuah saluran segiempat dengan 90 m lebar, n = 0.025 dan berkecerunan 0.0006 digunakan untuk mengalirkan air pada kedalaman normal sebanyak 3 m. Apabila struktur empang diletakkan di hilir saluran, profil aliran berubah ke arah hulu dan meningkat sebanyak 6% daripada kedalaman normal. Kirakan profil permukaan aliran tersebut menggunakan kaedah terperingkat terus (*Direct Step Method*), (Kiraan mestilah dicatatkan dalam Jadual 2 di Lampiran II dalam 3 peringkat dan sertakan di dalam kertas jawapan)

(16 markah)

S5 (a) Nyatakan 2 kaedah analisis dimensi dalam bidang kejuruteraan.

(2 markah)

(b) Sebuah model alurlimpah berskala 1:50 boleh menampung 1.25 m^3/s air, kirakan kadaralir bagi prototaip? Sekiranya fenomena banjir mengambil masa 12 jam untuk berlaku pada prototaip, berapa lama ia akan berlaku pada model?

(6 markah)

(c) Tunjukkan

$$\frac{F}{\rho V^2 L^2} = \text{fn}\left[\frac{gL}{V^2}; \frac{\mu}{\rho VL}\right]$$

Apabila persamaan bagi daya rintang F pada sebuah kapal bergantung kepada panjang kapal L, halaju V, pecutan graviti g, dan sifat bendalir iaitu ketumpatan bendalir ρ dan kelikatan dinamik μ.

(12 markah)

S6. (a) Terangkan dengan ringkas beserta gambarajah mengenai satu sistem pam yang beroperasi bersiri dan selari.

(6 markah)

(b) Dua pam yang serupa iaitu pam A dan B beroperasi pada kelajuan 600 rpm. Dikatakan pendesak pam A berdiameter 50 cm dan kadar alir yang melaluinya ialah 0.4 m^3/s ketika turus tekanan 50 m. Kira saiz pendesak dan turus pam B apabila kadar alir ialah 0.3 m^3/s.

(7 markah)

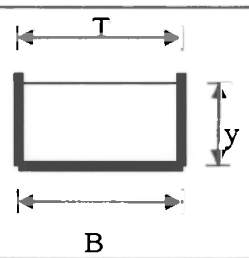
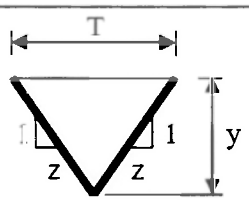
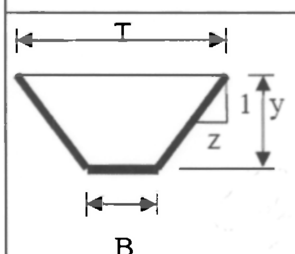
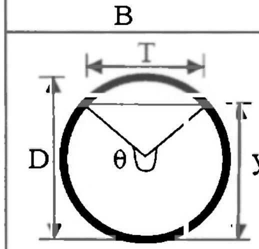
(c) Diberi kuasa turbin ialah 8500 kW pada 150 rpm dengan turusnya 20 m. Kira kuasa turbin jika turus direndahkan kepada 10 m.

(7 marks)

Appendix I

FINAL EXAMINATION
SEMESTER/SESSION : SEMESTER I/2009/2010 COURSE : 2 BFC
KURSUS : HYDRAULIC COURSE CODE : BFC 2073

Table 1 :Geometry Types for Open Channel

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

SEMESTER/SESSION : SEMESTER I/2009/2010 COURSE : 2 BFC

KURSUS : HYDRAULIC COURSE CODE : BFC 2073

Name:………………………………

Matrix Number:…………………………

Table 2 :Water Surface Profile

y (m)	**R** (m)	**v** (m)	**$v^2/2g$** (m)	**E** (m)	**ΔE** (m)	i	$\bar{i}$	$S_o - \bar{i}$	**ΔX** (m)	**L** (m)

Appendix III

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I/2009/2010 COURSE : 2 BFC

KURSUS : HYDRAULIC COURSE CODE : BFC 2073

Table 3 : Dimensional and Quantity for Fluid Mechanics

Kuantiti	Quantity	Simbol	Dimensi
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	$M^{0}L^{0}T^{0}$
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		$ML^{2}T^{-1}$
Momen momentum	Moment of momentum		$ML^{2}T^{-1}$
Momen daya	Force moment	T	$ML^{2}T^{2}$
Daya kilas	Torque	T	$ML^{2}T^{-2}$
Tenaga	Energy	E	L
Kerja	Work	W	$ML^{2}T^{-2}$
Kuasa	Power	P	$ML^{2}T^{-3}$
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	$L^{3}T^{-1}$
Kelikatan kinematik	Kinematic viscosity	υ	$L^{2}T^{-1}$
Fungsi arus	Stream function	Ψ	$L^{2}T^{-1}$
Putaran	Circulation	Γ	$L^{2}T^{-1}$
Pusaran	Vorticity	Ω	T^{-1}

Appendix III

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I/2009/2010 COURSE : 2 BFC

KURSUS : HYDRAULIC COURSE CODE : BFC 2073

Table 3 : Dimensional and Quantity for Fluid Mechanics

Kuantiti	Quantity	Simbol	Dimensi
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 IV

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I/2009/2010 COURSE : 2 BFC

KURSUS : HYDRAULIC COURSE CODE : BFC 2073

EQUATIONS

$$Q = \frac{1}{n} A R^{2/3} S_o^{1/2}$$

$$y_c = \left(\frac{q^2}{g} \right)^{1/3}$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8F_r^2} \right]$$

$$E_L = \frac{(y_2 - y_1)^3}{4 y_1 y_2}$$

$$F_r = \frac{V}{\sqrt{gy}}$$

$$P = \gamma Q E_L$$

$$E = y + \frac{Q^2}{2gA^2}$$

$$Z = \frac{Q}{\sqrt{g}} = A\sqrt{D}$$

$$P = \eta_o \gamma Q H$$

$$P_2 = P_1 \left(\frac{H_2}{H_1} \right)^{3/2}$$

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

$$N_2 = N_1 \sqrt{H_2 / H_1}$$

$$\Delta x = \frac{\Delta E}{S_o - i}$$

$$i = \frac{n^2 v^2}{R^{4/3}}$$

$$\left(\frac{NQ^{1/2}}{H^{3/4}} \right)_1 = \left(\frac{NQ^{1/2}}{H^{3/4}} \right)_2$$

$$\left(\frac{Q}{ND^3} \right)_1 = \left(\frac{Q}{ND^3} \right)_2$$

$$\left(\frac{H}{N^2 D^2} \right)_1 = \left(\frac{H}{N^2 D^2} \right)_2$$