Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 21103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Define the following:
(i) Hydraulic depth
(ii) Open channel flow
(iii) Non prismatic channel
(iv) Reynolds number

(4 marks)

(b) **FIGURE Q1(b)** shows water flowing through a 1-m diameter vitrified sewer at rate of 0.4 m^3/s. The sewer pipe is half-full. Determine:

(i) Longitudinal slope of sewer if Manning roughness coefficient is 0.013.

(6 marks)

(ii) State of the flow based on Reynolds number, where $\nu = 1.004 \times 10^{-6}$ m^2/s.

(4 marks)

(c) A compound channel shown in **FIGURE Q1(c)** is used to convey 0.0733 m^3/s of flow. If channel longitudinal slope and Chezy's flow resistance coefficient are 0.0003 and 60, respectively, calculate:
(i) Normal depth of flow
(ii) State of flow based on Froude number.

(11 marks)

Q2 (a) Describe with aid of sketch the following:
(i) Specific energy
(ii) Control section

(4 marks)

(b) Control section is a section that controls the conditions of upstream or downstream flow. Explain **TWO (2)** differences each for Case 1, Case 2 and Case 3 of flow through constricted channel.

(4 marks)

(c) A 4.5 m-wide rectangular channel is expected to discharge 50 m^3 of water in 10 s under depth of 3 m. At a section, width of channel is reduced to 3.5 m, calculate depth of flow upstream and downstream of constriction.

(7 marks)

(d) A 3 m-high broad-crested weir is constructed in the channel in **Question Q2(c)**. Assess depth of flow at upstream, downstream and above the weir.

(10 marks)

Q3 (a) Explain briefly **TWO (2)** applications of hydraulic jump and **TWO (2)** importance of gradually varied flow analysis.

(4 marks)

(b) Hydraulic jump occurs in a rectangular channel causing energy loss of 3.5 m. If supercritical upstream flow has Froude number of 9.0, determine the conjugate depths.

(5 marks)

(c) Flow through a concrete rectangular channel with Manning's n = 0.017 falls freely into a reservoir at rate of 7.8 m^3/s. Width and longitudinal slope of the channel is 5 m and 0.0006, respectively. At inlet of the reservoir, flow becomes critical. Using numerical integration method with 4 steps, determine type and depth of gradually-varied flow profile produced. Answers should be provided in four significant figures.

(13 marks)

(d) Based on findings from **Question Q3(c)**, plot the resultant water surface profile.

(3 marks)

Q4 (a) Explain briefly, applications of the following hydraulic structures.

(i) Spillway
(ii) Sluice gate
(iii) Energy dissipator

(6 marks)

(b) Sharp-crested weir is installed at a section of a 1 m-wide rectangular channel. The channel is discharging flow under 36 cm head. Considering coefficient of discharge of 0.60, calculate rate of flow if the following weir is used.

(i) Triangular weir with side slope 1(H) : 2(V)
(ii) 1.0 m wide rectangular weir
(iii) 0.3 m bottom-width trapezoidal weir with side slope 1(H) : 1(V).

(6 marks)

(c) A 16 m-wide rectangular spillway is discharging flood flow at a rate of 230 m^3/s at 1.0 m depth. Design an USBR Type III stilling basin at toe of the spillway.

(9 marks)

(d) Pump is required to supply 25000 L/s of water to a residential area under a head of 18 m. If two identical pumps installed in series are to be used, examine power delivered to the flow by each pump, shaft power and speed of each pump if efficiency is 70% when torque is 12 kNm.

(4 marks)

– END OF QUESTIONS –

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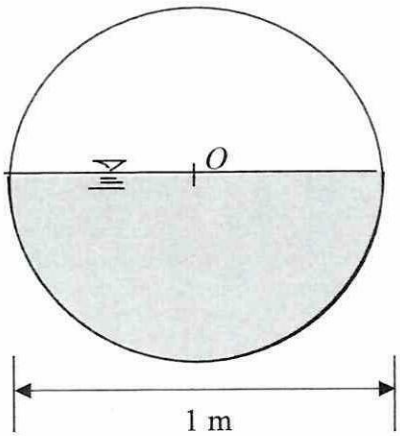

FIGURE Q1(b)

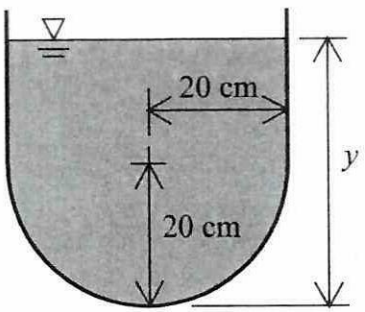

FIGURE Q1(c)

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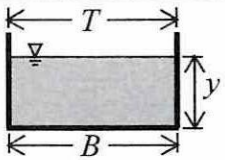
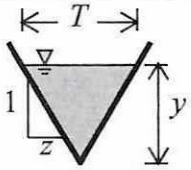
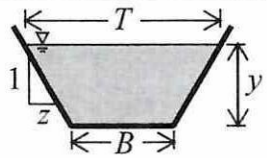
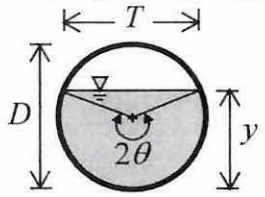
TABLE 1

Section	Flow area A	Top width T	Wetted perimeter P
 Rectangular	By	B	$B+2y$
 Triangular	zy^2	$2zy$	$2y\sqrt{1+z^2}$
 Trapezoidal	$By+zy^2$	$B+2zy$	$B+2y\sqrt{1+z^2}$
 Circular	$\frac{D^2}{8}(2\theta-\sin 2\theta)$	$D\sin\theta$	θD

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Equations sheet

$$Q = AV \qquad q = yV \qquad Q = \frac{1}{n}AR^{\frac{2}{3}}S_o^{\frac{1}{2}}$$

$$R = \frac{A}{P} \qquad D = \frac{A}{T} \qquad y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$\mathrm{Fr} = \frac{V}{\sqrt{gD}} \qquad \mathrm{Re} = \frac{VR}{v} \qquad E_{\min} = \frac{3}{2}y_c$$

$$E = y + \frac{Q^2}{2gA^2} \qquad E_L = \frac{(y_2 - y_1)^3}{4y_1y_2} \qquad \frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8\mathrm{Fr}_1^2}\right)$$

$$Q = \frac{8}{15}C_d\sqrt{2g}\,H_1^{\frac{5}{2}}\tan\left(\frac{\theta}{2}\right) \qquad Q = \frac{2}{3}C_d\sqrt{2g}\,LH_1^{\frac{3}{2}} \qquad P = \gamma QH$$

$$Q = \frac{2}{3}C_d\sqrt{2g}\,H_1^{\frac{3}{2}}\left(L + \frac{4}{5}H_1\tan\theta\right) \qquad \mathrm{E}_{1,3}{}' = \mathrm{E}_{\min} + \mathrm{H}_2 \qquad P_L = \rho gQE_L$$

$$\eta = \frac{P_o}{P_i} \qquad L_2 = 0.8y_2 \qquad \text{No. of blocks} = \frac{B}{(s+w)}$$

Block A	Block B	Block C
$h_1 = y_1$ $s_1 = y_1$ $w_1 = y_1$	$h_3 = (0.168\mathrm{Fr}_1 + 0.63)y_1$ $s_3 = 0.75h_3$ $w_3 = 0.75h_3$ $t_3 = 0.2h_3$ $z_3 = 1.0$	$h_4 = \left(\frac{\mathrm{Fr}_1}{18} + 1\right)y_1$ $z_4 = 2.0$