Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 21103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY/AUGUST 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 **SEVEN** (7) PAGES

Q1 (a) (i) Define specific energy.

(2 marks)

(ii) Explain the relevance of specific energy in determining critical conditions in a channel flow.

(2 marks)

(b) Discuss **TWO (2)** method to determine critical depth in open channel.

(5 marks)

(c) A 6.0 m wide of trapezoidal channel with side slope of 2(V):4(H) will be used to convey 17 m^3/s of water for a small paddy field during growing season. Calculate :-

(i) Critical depth using graph method.

(4 marks)

(ii) Critical slope, if Manning's n = 0.035

(4 marks)

(d) A trapezoidal channel having bottom width of 1.2 m conveys 0.72 m^3/s of flow with top width 1.75 m and uniform depth 0.5 m. If a broad-crested weir is to be installed at a section of the channel, analyze the minimum height of weir that will cause critical flow above the weir.

(8 marks)

Q2 (a) Discuss the formation of hydraulic jump on a flat surface with an aid of diagram.

(4 marks)

(b) Explain the objectives of flow profile analysis of gradually varied flow based on your civil engineering perspective views.

(5 marks)

(c) As an engineer, you are required to analyze the flow of water inside a rectangular channel of 3.5 m width that formed as part of dam spillway structure. At the toe of spillway, the base slope has changed to mild condition (S_o = 0.0075) creating the formation of hydraulic jump. Considering the flow depth after the jump is 1.2 m and, discharge of water is 7.1 m^3/s :-

(i) Sketch the problem in your perspective view and calculate the flow depth before the jump.

(3 marks)

(ii) Determine the energy before the jump, power loss per meter width of the channel and hence justify the hydraulic jump type.

(5 marks)

(d) Based on the same information as in **Q2(c)**, a sluice gate is installed at the downstream end which gradually rises depth after the jump to 2.0 m. Using numerical integration method with 3 steps of calculation :-

(i) Determine the distance, L of GVF flow profile.
(Assume that normal depth is equal to the depth before the jump. State your calculation up to 3 decimal places only).

(6 marks)

(ii) Illustrate sketch of the problem and validate the GVF increment of flow depth with respect to their horizontal distance and flow profile type.

(2 marks)

Q3 (a) Describe the application of spillway and sluice gate with the aids of sketches.

(4 marks)

(b) Explain briefly, the suppressed and contracted weir with the aids of sketches.

(5 marks)

(c) A weir is required to be installed at a section of a channel. Given that a head H_1 of 0.5 m and discharge coefficient, C_d for Cippoletti and triangular weir are 0.63 and 0.58, respectively. Calculate the discharge for :-

(i) Cippoletti weir with width 0.7 cm and side slope, 1(H) : 4(V).

(3 marks)

(ii) Triangular weir with vertex angle of 60°.

(3 marks)

(d) A rectangular spillway with a width of 8 m is discharging water at a rate of 100 m^3/s at a depth, y_1 of 0.5 m. Design a Type III USBR stilling basin at the base of the spillway as sketched in **Figure Q3(d)(i).** Please refer information in **Table Q3(d)** and **Figure Q3(d)(ii).**

(10 marks)

Q4 (a) Briefly discuss the function of pump and turbine.

(4 marks)

(b) Explain the potential location of cavitation that most likely to occur in pump operation.

(5 marks)

(c) The characteristics of a centrifugal pump model study are given in **Table Q4(c)**. The diameter of the impeller is 55 cm. If similar prototype of a diameter 0.85 m is to be designed :-

(i) Calculate the operational speed to deliver a flow of 0.2 m^3/s.

(4 marks)

(ii) Compute the attainable head at flow rate as mentioned in **Q4 (c)(i)**.

(4 marks)

(d) A Francis turbine produces 9010 kW at 650 rpm under a net head of 40 m with an overall efficiency of 92%. By assuming the same turbine under a net head of 60 m under homologous conditions :-

(i) Calculate the revolution per minute of the turbine.

(3 marks)

(ii) Determine the associated discharge by the turbine.

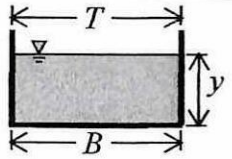
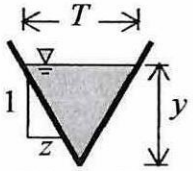
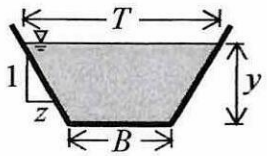
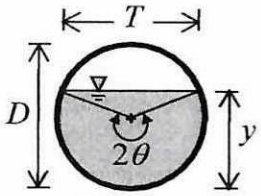
(5 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM II/2022/2023 PROGRAMME CODE : BFF
COURSE NAME : HYDRAULICS COURSE CODE : BFC 21103

Table 1 : General geometric element for calculation aid in Q1 to Q3

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

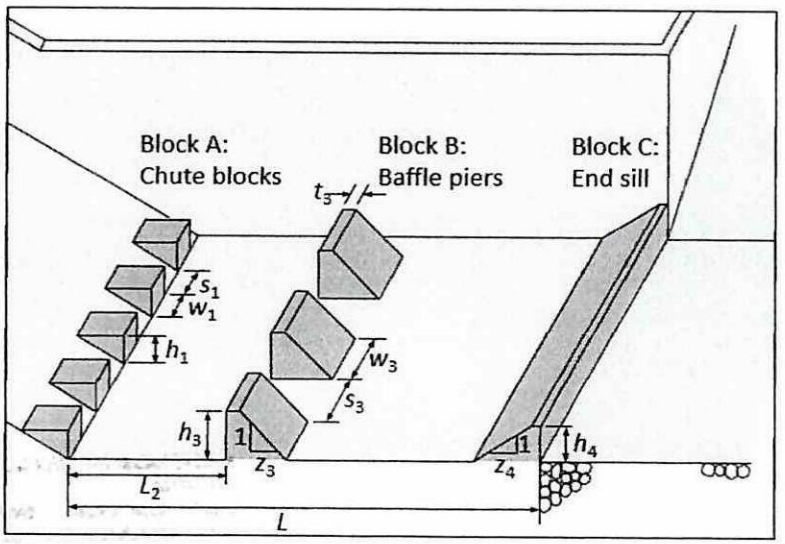


Figure Q3 (d)(i)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II/2022/2023 PROGRAMME CODE : BFF

COURSE NAME : HYDRAULICS COURSE CODE : BFC 21103

Table Q3 (d)

Block A	Block B	Block C
$h_1 = y_1$ $s_1 = y_1$ $w_1 = y_1$	$h_3 = (0.168Fr_1 + 0.63)y_1$ $s_3 = 0.75h_3$ $w_3 = 0.75h_3$ $t_3 = 0.2h_3$ $z_3 = 1.0$	$h_4 = \left(\frac{Fr_1}{18} + 1\right)y_1$ $z_4 = 2.0$

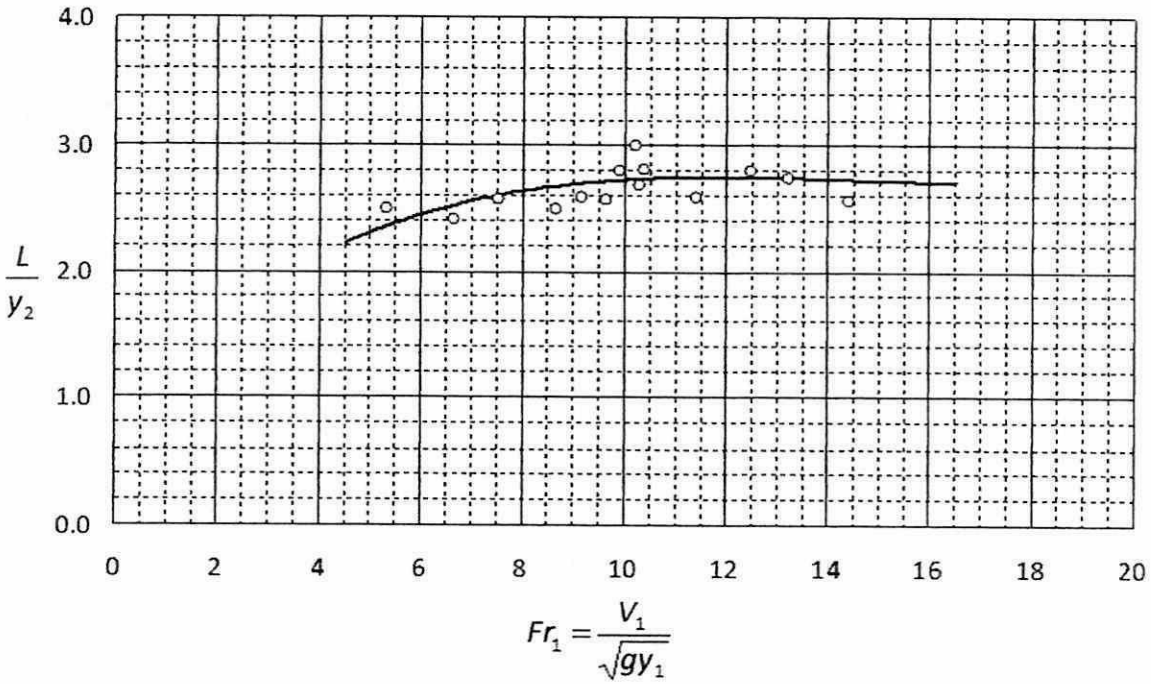


Figure Q3 (d)(ii)

Table Q4 (c)

Speed (rev/min)	1250
Discharge (m^3/min)	0.95
Head m	52

FINAL EXAMINATION

SEMESTER / SESSION : SEM II/2022/2023 PROGRAMME CODE : BFF

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Equations sheet

$$Q = Av \qquad q = yv \qquad Q = \frac{1}{n}AR^{2/3}\sqrt{S_o} \qquad R = \frac{A}{P} \qquad D = \frac{A}{T} \qquad y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$F_r = \frac{v}{\sqrt{gD}} \qquad R_e = \frac{vR}{\vartheta} \qquad E_{min} = \frac{3}{2}y_c \qquad S_c = \frac{n^2 g A_c}{T_c {R_c}^{4/3}} \qquad \frac{H_m}{{D_m}^2 {N_m}^2} = \frac{H_p}{{D_p}^2 {N_p}^2}$$

$$\frac{Q_m}{N_m {D_m}^3} = \frac{Q_p}{N_p {D_p}^3} \qquad N_{sm} = N_{sp} = \left(\frac{N_m\sqrt{Q_m}}{{H_m}^{3/4}}\right) = \left(\frac{N_p\sqrt{Q_p}}{{H_p}^{3/4}}\right) \qquad n_o = \frac{P_o}{P_i}$$

$$\frac{P_m}{\gamma_m {D_m}^5 {N_m}^3} = \frac{P_p}{\gamma_p {D_p}^5 {N_p}^3} \qquad N_u = \frac{N}{\sqrt{H}} \qquad Q_u = \frac{Q}{\sqrt{H}} \qquad P_u = \frac{P}{H^{3/2}}$$

$$No.\,of\ blocks = \frac{B}{s+w} \qquad L_2 = 0.8y_2 \qquad Q = \frac{2}{3}C_d\sqrt{2g}L{H_1}^{3/2}$$

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

$$\frac{{A_c}^3}{T_c} = \frac{Q^2}{g} \qquad H_{min} = E_o - E_{min} \qquad {Fr_1}^2 = \frac{q^2}{g{y_1}^3} \qquad \frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8{Fr_1}^2}\right]$$

$$E = y + \frac{q^2}{2gy^3} \qquad E = y + \frac{v^2}{2g} \qquad C_d = 0.611 + 0.075\left(\frac{H_1}{P}\right) \qquad E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

$$P_L = \rho g Q E_L \qquad \Delta y = \frac{y_{initial} - y_{end}}{Number\ of\ steps} \qquad K_o = \frac{Q}{\sqrt{S_o}} \qquad \Delta x = \frac{\Delta y}{S_o}.\left[\frac{1 - \left(\frac{y_c}{y_{avg}}\right)^3}{1 - \left(\frac{K_o}{K_{avg}}\right)^2}\right]$$

$$\Delta x = \frac{\Delta y}{S_o}.\left[\frac{1 - \left(\frac{Q^2T}{gA^3}\right)}{1 - \left(\frac{K_o}{K_{avg}}\right)^2}\right] \qquad \Delta x = \frac{\Delta y}{S_o}.\left[\frac{1 - \left(\frac{y_c}{y_{avg}}\right)^3}{1 - \left(\frac{y_o}{y_{avg}}\right)^{10/3}}\right] \qquad E_L = E_2 - E_1$$