UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 21103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) State of open channel flow is basically governed by viscosity and gravity effects relative to inertial forces of the flow. Briefly explain **TWO (2)** differences of flow states between these two effects.

(6 marks)

(b) A 78.74-inch diameter of semi-circular earth ground (clean) channel constructed on 0.5-percent slope carries discharge at 3500 L/s. Calculate the depth of uniform flow.

(6 marks)

(c) Following **Question Q1(b)**, if the same semi-circular is constructed, determine the state of flow based on Reynolds number, where $\nu = 1.004 \times 10^{-6}$ m^2/s.

(5 marks)

(d) Water flows in a 20000-m long smooth-asphalt trapezoidal channel at 55 m^3/s with side slope of 2.5(H):1(V). Elevations at the beginning and end of channel are 400 m and 376 m, respectively. Analyse its efficient-channel section.

(8 marks)

Q2 (a) Describe with the aid of sketch the following:

(i) Gradually varied flow

(2 marks)

(ii) Control section

(2 marks)

(b) A control section 'controls' the upstream or downstream flow. With the aid of diagram, equation and specific energy curve, explain **TWO (2)** differences between Case 1, Case 2 and Case 3 for flow through constricted channel.

(4 marks)

(c) A clean earth ground rectangular channel with 6 m width laid on a slope of 0.006. Water flows at 30 m^3/s in the channel and enters a reservoir as shown in **Figure Q2(c)**. Depth of water increases to 3 m before the entry which is two times of the normal depth. Calculate:

(i) Critical depth of flow and type of channel slope.

(2 marks)

(ii) Length L of water surface profile using Direct Step Method in 2 steps.

(7 marks)

(d) A bridge is to be built across a 7.5 m wide almost rectangular river with uniform flow depth of 2.5 m, bed slope of 1/2000, and perimeter roughness n = 0.030. If a 1.5 m high broad-crested weir is built across the river section to measure the rate of flow, determine the depth of flow upstream, above, and downstream of the weir.

(8 marks)

Q3 (a) Water flows inside a rectangular channel with longitudinal slope 1:1000 and Manning's roughness coefficient of 0.012. A compound shape-notch weir is placed inside the channel and the head is shown in **Figure Q3(a)**. Calculate discharge through the notch weir.

(6 marks)

(b) A combination series of 1.4 m length of rectangular notch weir A, B, C and D with various high from bottom was constructed downstream wise inside 2 m wide channel. Calculate discharge Q that is passing through each notch weir from A to D as shown in **Figure Q3(b)**.

(8 marks)

(c) Based on **Question Q3(b)**, sluice gate is to be constructed downstream of the channel. The purpose of the gate is to force the dissipation of the kinetic energy of the flow, downstream of the sluice gate, between the gate and the weir: i.e to induce a (fully developed) hydraulic jump between the gate and the weir. The difference between upstream water depth before sluice gate and downstream water depth after sluice gate is 4.5 m. With the coefficient of contraction C_c is 0.636, height of gate opening a is 2.2 m and coefficient of discharge C_d is 0.599, estimate water depth before hydraulic jump and the flow discharge if water depth before the weir is 0.7 m. Sketch the channel, sluice gate, hydraulic jump and sharp-crested weir.

(6 marks)

(d) Discuss the fundamental of hydraulic structure and control section. Give your own opinion on the application of hydraulic structure in water resources management.

(5 marks)

Q4 (a) An irrigation canal is constructed to supply water for hilly paddy farm.

(i) Explain with the aid of diagram and equation on how to setup system for two pumps from the irrigation canal to the paddy area located at edge of hill, to increase higher-pressure head H for better supply.

(7 marks)

(ii) From **Question Q4(a)(i)** purposes, if two identical pumps are used with pressure head, $H = 31$ m, design discharge at 1 m^3/s and system power of 21 kW, calculate the pressure head, discharge, total power required and overall pump efficiency for these two connected pumps.

(7 marks)

(b) A water turbine model is constructed at ratio of 1:8 with power system of 10 kW at speed of 555 rpm under a head of 2.5 m. Overall efficiency for both model and prototype is assumed at 0.93.

(i) Determine the specific speed.

(4 marks)

(ii) If the prototype is run under a head of 25 m, calculate its rotational speed, power and discharge.

(7 marks)

- END OF QUESTIONS -

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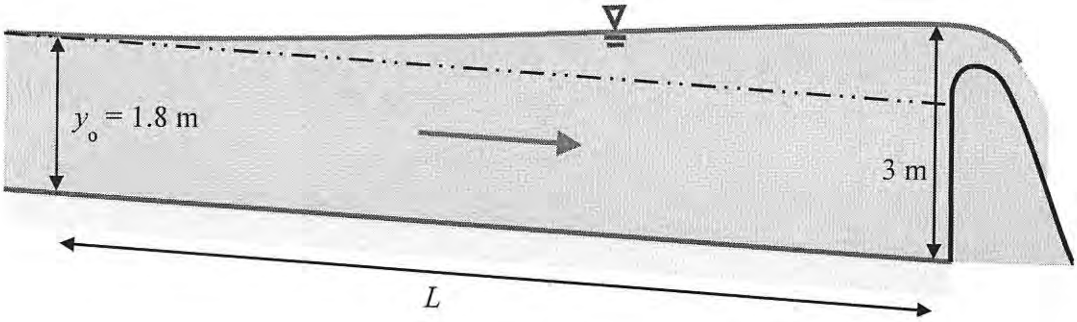

FIGURE Q2(c)

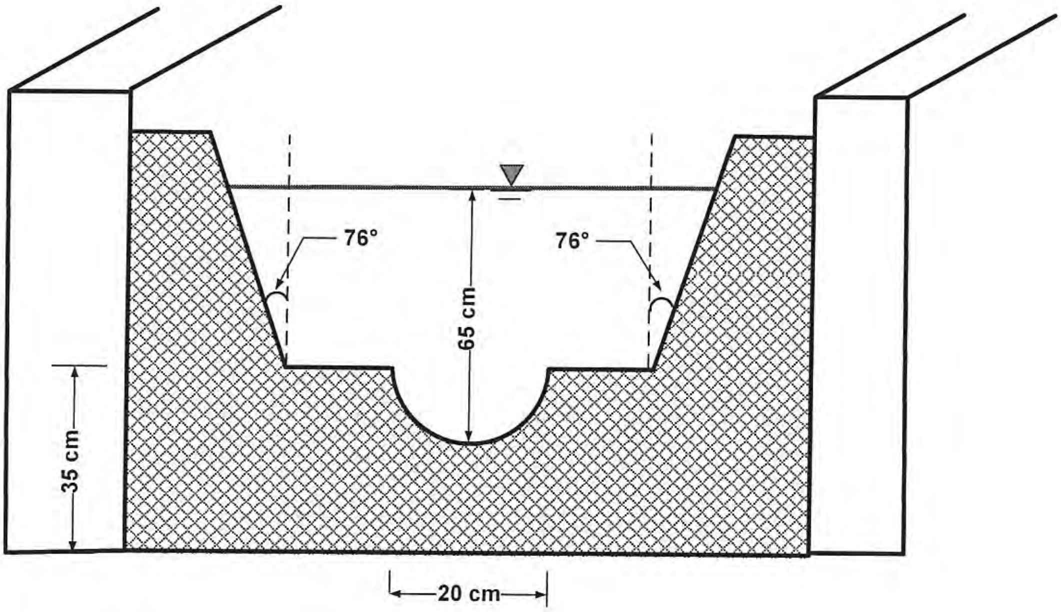

FIGURE Q3(a)

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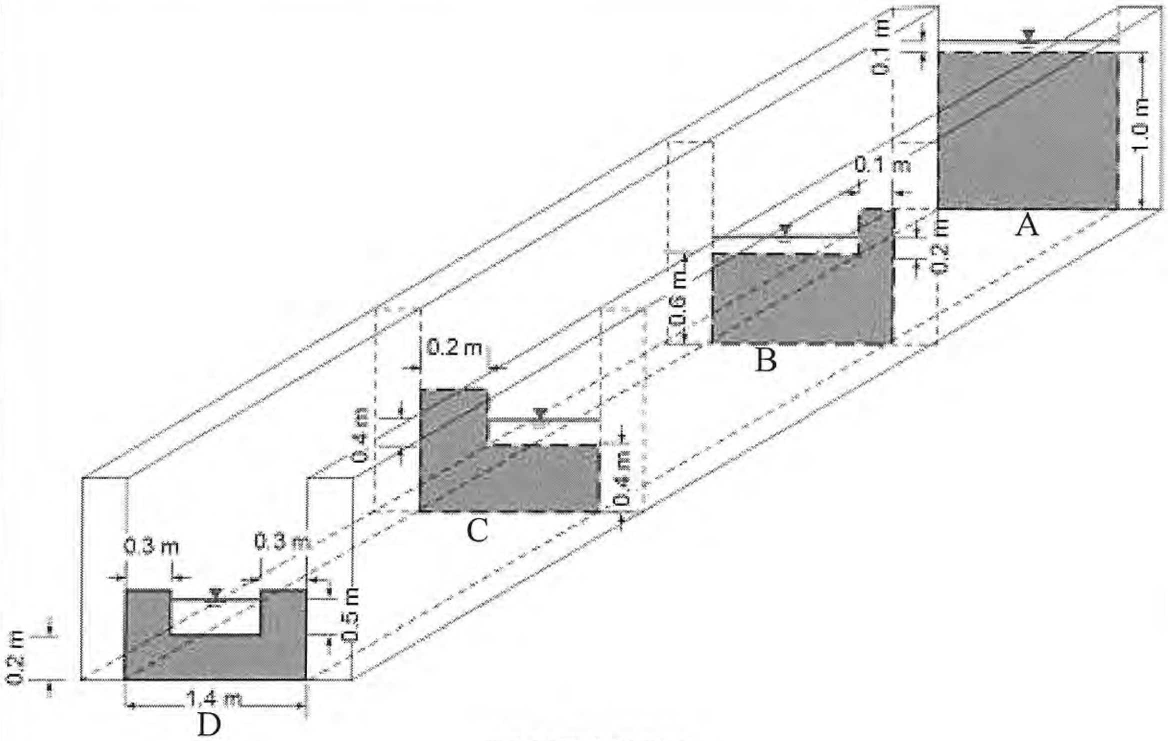

FIGURE Q3(b)

TABLE 1: Manning roughness coefficient

Channel type	Manning's *n*
Natural channel	
i. Clean and Straight	0.030
ii. Vegetation	0.100
iii. Mountain River	0.040 – 0.050
Artificial Channel	
i. Earth ground (clean)	0.022
ii. Earth ground (vegetation)	0.027 – 0.035
iii. Cement (plane/ smooth)	0.011
iv. Cement (mortar)	0.013
v. Concrete	0.017
vi. Asphalt (smooth)	0.013
vii. Asphalt (rough)	0.016
viii. Steel	0.012

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TABLE 2: Open channel flow section geometries

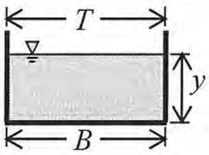
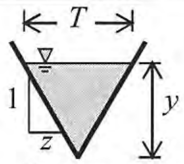
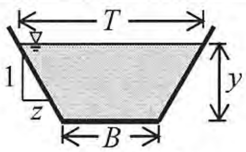
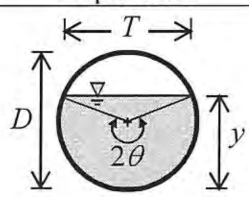
Section	Area A	Top width T	Wetted perimeter P
 Rectangular	By	B	$B+2y$
 Triangular	zy^2	$2zy$	$2y\sqrt{1+z^2}$
 Trapezoidal	$By+zy^2$	$B+2zy$	$B+2y\sqrt{1+z^2}$
 Circular	$\frac{D^2}{8}(2\theta-\sin 2\theta)$	$D\sin\theta$	θD

TABLE 3: Sizing for USBR Type III stilling basin

Block A	Block B	Block C
$h_1 = y_1$	$h_3 = y_1(0.168\text{Fr}_1 + 0.63)$	$h_4 = y_1\left(\frac{\text{Fr}_1}{18}+1\right)$
$w_1 = y_1$	$w_3 = \frac{3}{4}h_3$	$t = \frac{h_3}{5}$
$s_1 = y_1$	$s_3 = \frac{3}{4}h_3$	$z_2 = 2.0$
	$t = \frac{h_3}{5}$	
	$z_1 = 1.0$	
	$L_1 = \frac{4}{5}y_2$	

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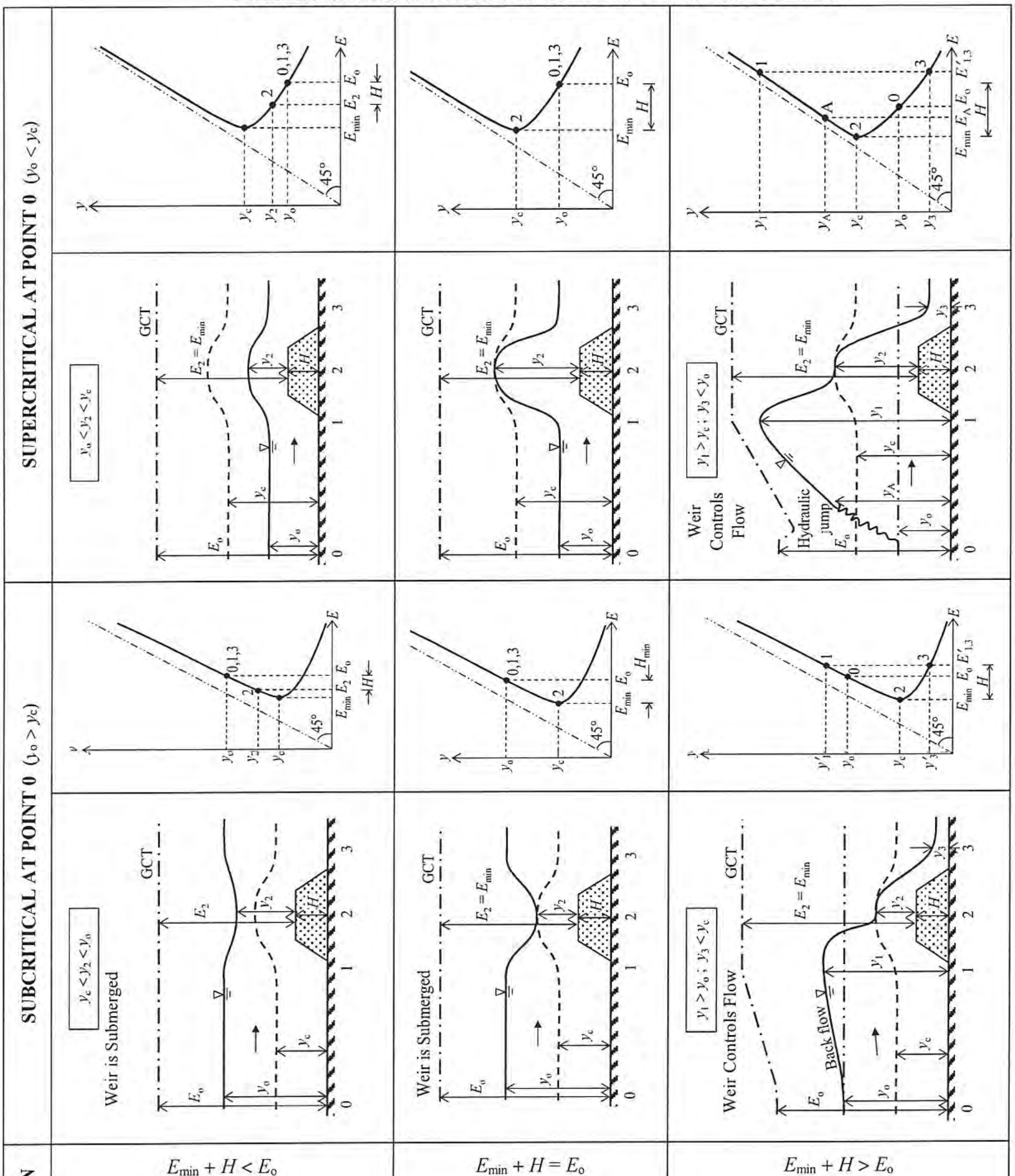
TABLE 4: Characteristics of flow over broad-crested weir



	CASE 1	CASE 2	CASE 3
CONDITION	$E_{min} + H < E_o$ or $H < H_{min}$ $y_1 = y_3 = y_o$ & $y_2 \neq y_c \rightarrow E_2 = E_o - H$	$E_{min} + H = E_o$ or $H = H_{min}$ $y1 = y_3 = y_o$ & $y_2 = y_c$	$E_{min} + H > E_o$ or $H > H_{min}$ $y_1 \neq y_3 \neq y_o$ & $y_2 = y_c \rightarrow E_2 = E_{min}$

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Equations sheet

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

$$\mathrm{Fr} = \frac{V}{\sqrt{gD}} \qquad \mathrm{Fr}^2 = \frac{q^2}{gy^3} \qquad \mathrm{Fr} = \frac{q}{\sqrt{gy}} \qquad \mathrm{Re} = \frac{VR}{\nu}$$

$$\frac{A_c^3}{T_c} = \frac{Q^2}{g} \qquad \frac{V_c}{\sqrt{gD_c}} = 1 \qquad y_c = \sqrt[3]{\frac{q^2}{g}} \qquad E_{\min} = \frac{3}{2}y_c$$

$$E = y + \frac{q^2}{2gy^2} \qquad E = y + \frac{V^2}{2g} \qquad E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8\mathrm{Fr}_1^2}\right) \qquad V_1 = \sqrt{2g(y_o - y_1)}$$

$$Q = \frac{2}{3}C_d\sqrt{2g}LH_1^{\frac{3}{2}} \qquad Q = \frac{2}{3}C_d\sqrt{2g}H_1^{\frac{3}{2}}\left(L + \frac{4}{5}H_1\tan\theta\right)$$

$$Q = C_d ab\sqrt{2g(y_o - y_1)} \quad \text{if} \quad (y_o - y_1) > y_2$$

$$Q = C_d ab\sqrt{2g(y_o - y_2)} \quad \text{if} \quad (y_o - y_1) \le y_2$$

$$dx = \frac{dE}{S_o - \bar{S}_f} \qquad dx = \frac{\left(y_2 + \frac{V_2^2}{2g}\right) - \left(y_1 + \frac{V_1^2}{2g}\right)}{S_o - \left[\frac{1}{2}\left(\frac{n^2V_1^2}{R_1^{\frac{4}{3}}} + \frac{n^2V_2^2}{R_2^{\frac{4}{3}}}\right)\right]}$$

$$P = \gamma QH \qquad P = \eta_o\gamma QH \qquad P = \frac{2\pi N}{60}T \qquad P_L = \rho g Q E_L$$

$$\frac{ND}{\sqrt{H}} \qquad \frac{Q}{ND^3} \qquad \frac{P}{D^5N^3} \qquad N_s = \frac{N\sqrt{P}}{H^{\frac{5}{4}}}$$

$$\frac{H}{N^2D^2} \qquad Q_u = \frac{Q}{\sqrt{H}} \qquad N_u = \frac{N}{\sqrt{H}} \qquad P_u = \frac{P}{H^{\frac{3}{2}}}$$