KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI II : 2025/2026

DCC40412 : HYDRAULICS

TARIKH : 06 MEI 2026
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Subjektif (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This section consists of **FOUR (4)** subjective questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1 (a) With the aid of a diagram, explain the forces acting on a vertical plate immersed in a liquid.

Dengan bantuan gambar rajah, terangkan daya yang bertindak pada plat menegak yang direndam dalam cecair.

[5 marks]

[*5 markah*]

CLO1 (b) A circular water gate of 60 cm diameter is immersed in water at an inclination of 35° to the free surface with its top edge 1.5 m below the water surface as shown in Figure 1(b). Determine the difference between the height of center of gravity and the height of center of pressure on the gate.

Sebuah pintu air berbentuk bulatan berdiameter 60 cm direndam dalam air pada kecondongan 35° ke permukaan bebas dengan tepi atasnya 1.5 m di bawah permukaan air seperti yang ditunjukkan dalam Rajah 1(b). Tentukan perbezaan antara ketinggian pusat graviti dan ketinggian pusat tekanan pada pintu tersebut.

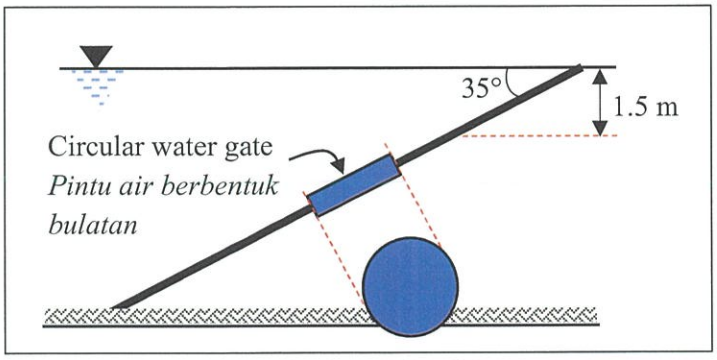


Figure 1(b) / *Rajah 1(b)*

[8 marks]

[*8 markah*]

CLO1 (c) A curved gate AB is submerged in a liquid as shown in Figure 1(c). Determine the resultant force per meter of length due to water pressure acting on the curve gate AB with 4 m radius.

Pintu melengkung AB ditenggelamkan dalam cecair seperti yang ditunjukkan dalam Rajah 1(c). Tentukan daya terhasil per meter panjang disebabkan oleh tekanan air yang bertindak pada pintu lengkung AB dengan jejari 4 m.

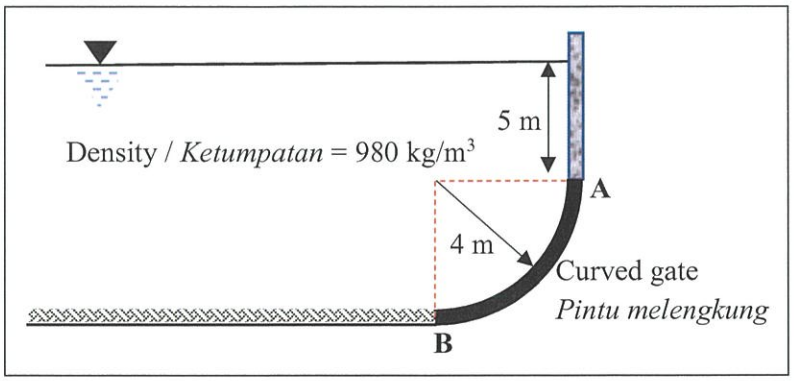


Figure 1(c) / *Rajah 1(c)*

[12 marks]

[*12 markah*]

QUESTION 2
SOALAN 2

CLO1 (a) The metacentric is defined as the point of which a floating body starts to oscillate when it is tilted through a small angle. With the aid of a labelled diagram, explain the concept of metacentric height of a floating body and its significance to stability.

Pusat meta ditakrifkan sebagai titik di mana jasad terapung mula berayun apabila jasad tersebut dicondongkan pada sudut kecil. Dengan bantuan gambar rajah berlabel, terangkan konsep ketinggian pusat meta bagi jasad terapung serta kepentingannya terhadap kestabilan,

[5 marks]

[*5 markah*]

CLO1 (b) A wooden block with a length of 3.0 m, width of 1.25 m, and depth of 0.75 m is floating in water. The specific weight of the wood is 6.4 kN/m^3. Determine the position of centre of buoyancy, OB.

Sebuah bongkah kayu dengan panjang 3.0 m, lebar 1.25 m, dan kedalaman 0.75 m terapung di dalam air. Berat tentu kayu ialah 6.4 kN/m^3. Tentukan kedudukan pusat keapungan, OB.

[8 marks]

[*8 markah*]

CLO1 (c) A wooden block with a specific gravity of 0.80 floats in water. The dimensions of the block are 1.2 m × 0.6 m × 0.5 m. Calculate the metacentric height of the floating block.

Sebuah bongkah kayu dengan graviti tentu 0.80 terapung di dalam air. Dimensi bongkah tersebut ialah 1.2 m × 0.6 m × 0.5 m. Kirakan ketinggian pusat meta bongkah tersebut.

[12 marks]

[*12 markah*]

QUESTION 3
SOALAN 3

CLO2 (a) During the inspection of an open channel system, technicians need to understand the flow conditions to ensure the proper operation. With the aid of a diagram, explain the uniform flow in an open channel by showing the flow depth (y), flow velocity (v) and channel bed slope (S_o).

Semasa pemeriksaan saluran terbuka, juruteknik perlu memahami keadaan aliran bagi memastikan sistem beroperasi dengan baik. Dengan bantuan gambar rajah, terangkan keadaan aliran seragam dalam saluran terbuka dengan menunjukkan kedalaman aliran (y), halaju aliran (v) dan cerun dasar saluran (S_o).

[4 marks]
[*4 markah*]

CLO2 (b) Manning's equation is used to determine the velocity and discharge of water flowing in an open channel based on channel dimensions, roughness coefficient and bed slope to evaluate the flow condition. Calculate the velocity and discharge for a rectangular channel 0.5 m wide with a flow depth of 0.25 m. The Manning's coefficient is 0.022 and the bed slope is 1 in 200.

Persamaan Manning digunakan untuk menentukan halaju dan kadar alir dalam saluran terbuka berdasarkan dimensi saluran, pekali kekasaran dan kecerunan dasar untuk menilai keadaan aliran. Kirakan halaju dan kadar alir untuk saluran segi empat tepat selebar 0.5 m dengan kedalaman aliran 0.25 m. Pekali Manning ialah 0.022 cerun dasar ialah 1 dalam 200.

[9 marks]
[*9 markah*]

CLO2 (c) In sewer design, engineers analyse flow conditions using Manning's equation to obtain the roughness coefficient of a pipe. Evaluate the value of Manning's coefficient for a sewer pipe 1000 mm in diameter discharging water at a rate of 400 L/s. The sewer runs half full and is laid at a slope of 1 in 900.

Dalam reka bentuk pembetung, jurutera menganalisis keadaan aliran menggunakan persamaan Manning untuk mendapatkan pekali kekasaran paip. Nilaikan pekali Manning untuk paip pembetung berdiameter 1000 mm yang mengeluarkan air pada kadar 400 L/s. Pembetung tersebut mengalir separuh penuh dan dipasang pada cerun 1 dalam 900.

[12 marks]

[*12 markah*]

QUESTION 4
SOALAN 4

CLO2 (a) In open channel flow, a rapid change in flow condition may occur when high velocity water suddenly slows down due to changes in channel conditions. With the aid of a diagram, explain the formation of a hydraulic jump.

Dalam aliran saluran terbuka, perubahan keadaan aliran yang cepat boleh berlaku apabila air berhalaju tinggi tiba-tiba menjadi perlahan disebabkan oleh perubahan keadaan saluran. Dengan bantuan gambar rajah, terangkan pembentukan lompatan hidraulik.

[4 marks]

[*4 markah*]

CLO2 (b) In open channel, sluice gates are used to control water flow and may create critical flow conditions downstream of the gate. The water flow in an open channel is 0.2 m^3/s and an adjustable sluice gate is installed across a 0.9 m wide channel. Determine the water depth downstream of the sluice, velocity at critical flow and minimun specific energy.

Dalam saluran terbuka, pintu air digunakan untuk mengawal aliran air dan boleh menghasilkan keadaan aliran kritikal di bahagian hilir pintu air. Kadar aliran air dalam saluran terbuka ialah 0.2 m^3/s, dan satu pintu air boleh laras dipasang merentasi saluran selebar 0.9 m. Tentukan kedalaman air di hilir pintu air, halaju pada aliran kritikal dan tenaga tentu mimima.

[9 marks]

[*9 markah*]

CLO2 (c) In the maintenance of an open channel system, technicians analyse flow parameters to determine the specific energy and critical flow conditions. A rectangular open channel 2 m wide carries a discharge of 9000 L/s, and the average flow velocity is 1.5 m/s. Evaluate the specific energy, critical velocity, and minimum specific energy of the flow.

Dalam kerja penyelenggaraan saluran terbuka, juruteknik perlu menganalisis parameter aliran untuk menentukan tenaga spesifik dan keadaan aliran kritikal. Sebuah saluran terbuka berbentuk segi empat tepat dengan lebar 2 m mengalirkan air pada kadar 9000 L/s, dan halaju purata aliran ialah 1.5 m/s. Nilaikan tenaga spesifik, halaju kritikal dan tenaga spesifik minimum bagi aliran tersebut.

[12 marks]

[*12 markah*]

SOALAN TAMAT

FORMULA DCC40412: HYDRAULICS

HYDROSTATIC FORCE

$$F_R = \rho \times g \times h_{cg} \times A$$

$$h_{cp} = \frac{I_c \times \sin^2\theta}{A \times h_{cg}} + h_{cg}$$

$$F_H = \rho \times g \times h_{cg} \times A$$

$$F_V = \rho \times g \times V$$

$$F_R = \sqrt{(F_H)^2 + (F_V)^2}$$

$$\alpha = \tan^{-1}\left(\frac{F_V}{F_H}\right)$$

$$h_{cp} = \frac{F_1\left(\frac{2}{3}h_1\right) - F_2\left(\frac{2}{3}h_2\right)}{F_R}$$

$$F_1 = \frac{1}{2}(\rho_1 \times g \times h_1)h_1 \times L$$

$$F_2 = (\rho_1 \times g \times h_1)h_2 \times L$$

$$F_3 = \frac{1}{2}(\rho_2 \times g \times h_2)h_2 \times L$$

$$F_R = F_1 + F_2 + F_3$$

$$F_R = F_1 - F_2$$

$$h_{cp} = \frac{2}{3}H$$

$$h_{cp} = \frac{F_1\left(\frac{2}{3}h_1\right) + F_2\left(\frac{h_2}{2} + h_1\right) + F_3\left(\frac{2}{3}h_2 + h_1\right)}{F_R}$$

BUOYANCY AND FLOATATION

$$W = \rho_b \times g \times V_b$$

$$F_B = \rho_f \times g \times V_d$$

$$BG = OG - OB$$

$$BM = \frac{I_C}{V_d}$$

$$GM = BM - BG$$

UNIFORM OPEN CHANNEL

$$Q = A \times v$$

$$v = \frac{R^{\left(\frac{2}{3}\right)} \times S_o^{\left(\frac{1}{2}\right)}}{n}$$

$$Q = \frac{A \times R^{\left(\frac{2}{3}\right)} \times S_O^{\left(\frac{1}{2}\right)}}{n}$$

$$R = \frac{A}{P}$$

Best hydraulics cross section

Rectangular

$$b = 2y$$

Trapezoidal

$$b + 2zy = 2y\sqrt{1 + z^2}$$

Circular

$$r = y$$

NON-UNIFORM OPEN CHANNEL

$$E = y + \left[\frac{v^2}{2 \times g}\right]$$

$$E = y + \left[\frac{Q^2}{2 \times g \times A^2}\right]$$

$$F_r = \frac{v}{\sqrt{g \times y}}$$

$$y_1 = \frac{y_2}{2}\left[\sqrt{1 + (8 \times {Fr_2}^2)} - 1\right]$$

$$y_2 = \frac{y_1}{2}\left[\sqrt{1 + (8 \times {Fr_1}^2)} - 1\right]$$

$$\Delta y = y_2 - y_1$$

$$v_c = \sqrt{g \times y_c}$$

$$y_c = \left[\frac{Q^2}{b^2 \times g}\right]^{\frac{1}{3}}$$

$$y_c = \left[\frac{q^2}{g}\right]^{\frac{1}{3}}$$

$$E_{min} = \frac{3}{2}\, y_c$$

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

$$P = \rho \times Q \times g \times E_L$$

Table A1: *Geometric Properties of Plane Surface*

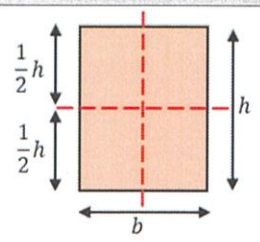
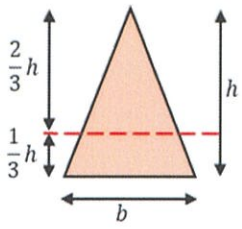
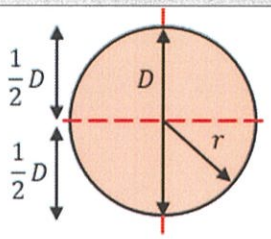
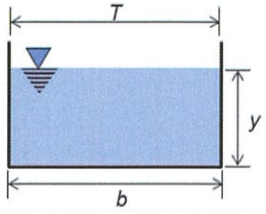
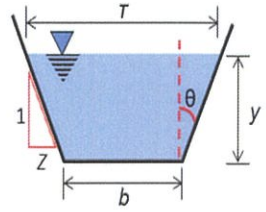
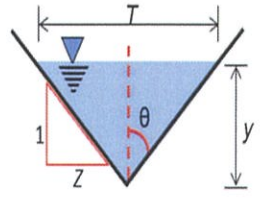
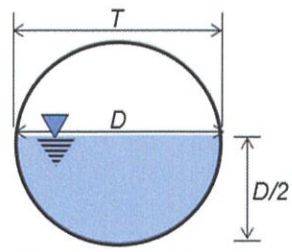
Shape	Rectangle	Triangle	Circle
			
Area, A (m^2)	$A = bh$	$A = \frac{1}{2}bh$	$A = \frac{\pi D^2}{4} = \pi r^2$
Moment of Inertia, I_c (m^4)	$I_c = \frac{bh^3}{12}$	$I_c = \frac{bh^3}{36}$	$I_c = \frac{\pi D^4}{64} = \frac{\pi r^4}{4}$

Table A2: *Geometric Properties of Open Channel Cross-section*

Section	Area, A (m^2)	Wetted Perimeter, P (m)	Top Width, T (m)
Rectangular 	$A = by$	$P = b + 2y$	$T = b$
Trapezoidal 	$A = by + zy^2$	$P = b + 2y\sqrt{1+z^2}$	$T = b + 2zy$
	$A = by + y^2(\tan\theta)$	$P = b + 2y\sqrt{1+(\tan\theta)^2}$	$T = b + 2y(\tan\theta)$
Triangular 	$A = zy^2$	$P = 2y\sqrt{1+z^2}$	$T = 2zy$
	$A = y^2(\tan\theta)$	$P = 2y\sqrt{1+(\tan\theta)^2}$	$T = 2y(\tan\theta)$
Semi-circular 	$A = \frac{\pi r^2}{2}$	$P = \pi r$	$T = 2r$
	$A = \frac{\pi D^2}{8}$	$P = \frac{\pi D}{2}$	$T = D$