SULIT

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 : 2024/2025

DCC50222 : HYDRAULICS

TARIKH : 21 MEI 2025
MASA : 11.30 PAGI - 1.30 PETANG (2 JAM)

Kertas ini mengandungi **DUA BELAS (12)** halaman bercetak.
Bahagian A: Subjektif (2 soalan)
Bahagian B: Subjektif (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A : 50 MARKS
BAHAGIAN A : 50 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** subjective questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1 (a) Illustrate a suitable diagram of an object immersed in water at a depth of Xm below the free surface, indicating both the center of gravity and the center of pressure of the object.

Lakarkan rajah yang sesuai bagi objek yang tenggelam di dalam air pada kedalaman Xm di bawah permukaan bebas, dengan menunjukkan pusat graviti dan pusat tekanan objek tersebut.

[4 marks]
[*4 markah*]

CLO1 (b) Figure A1(b) shows a triangular plate with a base of 3 m and side lengths of 5 m, immersed vertically in water. Estimate the hydrostatic force acting on the plate.

Rajah A1(b) menunjukkan sebuah plat segi tiga dengan panjang asas 3 m dan panjang sisi 5 m yang tenggelam secara menegak di dalam air. Anggarkan daya hidrostatik yang bertindak ke atas plat tersebut.

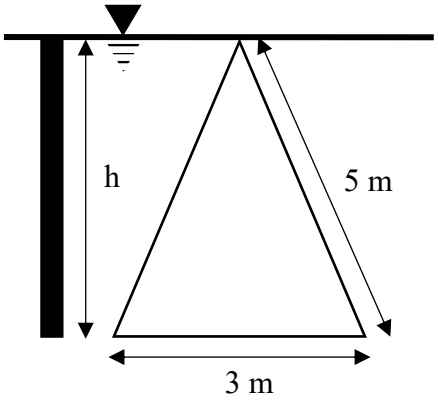


Figure A1(b) / *Rajah A1(b)*

[6 marks]
[*6 markah*]

CLO1 (c) Calculate the magnitude and direction of the force acting on the curved plate AB, which is located 4 meters below the free water surface. The curved plate has a length 1.8 m and radius 1.5 m, as shown in Figure A1(c) below.

Kirakan magnitud dan arah daya yang bertindak ke atas plat melengkung AB, yang terletak 4 meter di bawah permukaan air bebas. Plat melengkung tersebut mempunyai panjang 1.8 m dan jejari 1.5 m, seperti yang ditunjukkan dalam Rajah A1(c) di bawah.

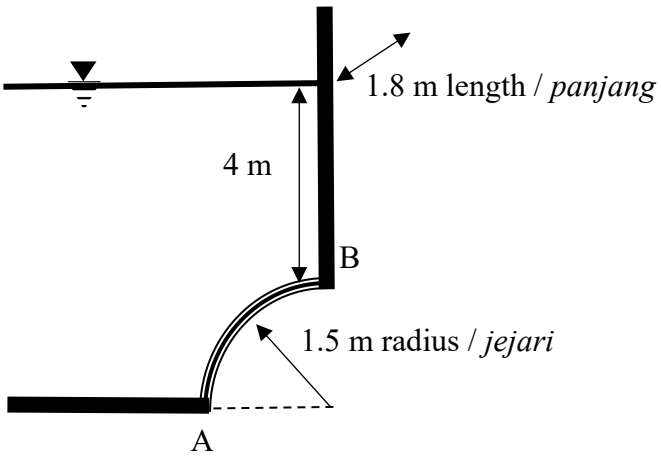


Figure A1(c) / *Rajah A1(c)*

[15 marks]
[*15 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) With the aid of a diagram, explain Metacentre and Centre of Buoyancy.

Dengan bantuan gambarajah, terangkan Pusat Meta dan Pusat Keapungan.

[4 marks]

[*4 markah*]

CLO1 (b) An iceberg has a specific weight of 8.18 kN/m³, as shown in Figure A2(b). If the iceberg displaces 40 m³ of seawater ($\rho_{seawater}$ = 1025kg/m$^{3)}$, estimate the total volume of the iceberg that remains above the seawater surface.

Sebuah gunung ais mempunyai berat tentu 8.18 kN/m³, seperti yang ditunjukkan dalam Rajah A2(b). Jika gunung ais tersebut menyesarkan 40 m³ air laut ($\rho_{air\ laut}$ = 1025 kg/m³), anggarkan jumlah isipadu gunung ais yang berada di atas permukaan air laut.

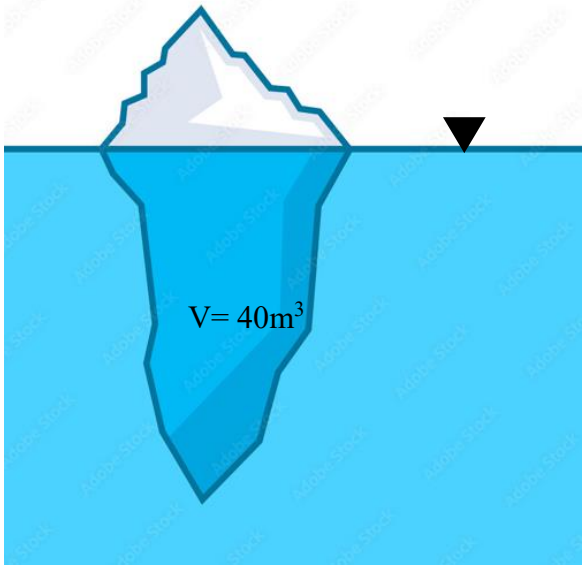


Figure A2(b) / *Rajah A2(b)*

[6 marks]

[*6 markah*]

CLO1

(c) A solid cylindrical buoy, with a diameter of 700 mm and a length of 1200 mm, floats upright in seawater, (s.g = 1.025) as shown in Figure A2(c) below. The buoy is made from a combination of High-Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) foam materials with a specific gravity of 0.90. Determine whether the buoy will be stable or unstable.

Sebuah pelampung silinder pepejal, dengan diameter 700 mm dan panjang 1200 mm, terapung tegak di dalam air laut,(s.g = 1.025) seperti yang ditunjukkan dalam Rajah A2(c) di bawah. Pelampung ini diperbuat daripada gabungan bahan Polietilena Ketumpatan Tinggi (HDPE) dan buih Polistirena Diperluas (EPS), dengan gravity tentu 0.90. Tentukan sama ada pelampung ini akan stabil atau tidak stabil.

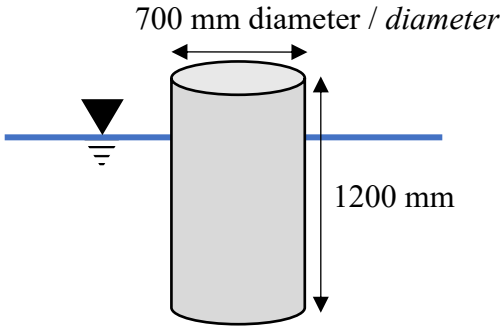


Figure A2(c) / *Rajah A2(c)*

[15 marks]

[*15 markah*]

SECTION B : 50 MARKS

BAHAGIAN B : 50 MARKAH

INSTRUCTION:

This section consists of **FOUR (4)** subjective questions. Answer **TWO (2)** questions only.

ARAHAN :

*Bahagian ini mengandungi **EMPAT (4)** soalan subjektif. Jawab **DUA (2)** soalan sahaja.*

QUESTION 1

SOALAN 1

CLO 2 (a) Estimate the wetted perimeter of the trapezoidal open channel as shown in Figure B1(a).

Anggarkan perimeter basah bagi saluran terbuka berbentuk trapezoid seperti yang ditunjukkan dalam Rajah B1(a).

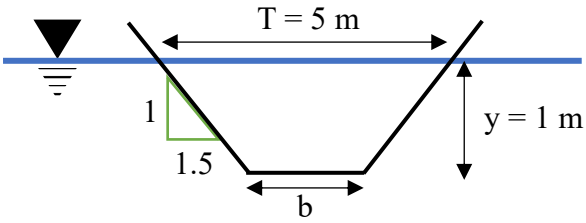


Figure B1(a) / *Rajah B1(a)*

[4 marks]

[*4 markah*]

CLO 2 (b) A wastewater sewer pipe with a diameter of 1.5 m carries a flow rate of 2.5 m^3/s, with the pipe half-filled with water, as shown in Figure B1(b). Using a Manning roughness coefficient of 0.012, calculate the required bed slope of the pipe to maintain the necessary flow rate and achieve the self-cleaning capability of the pipe.

Sebuah paip pembetungan dengan diameter 1.5 m membawa aliran sebanyak 2.5 m^3/s, dengan paip tersebut separuh penuh dengan air seperti yang ditunjukkan dalam Rajah B1(b). Menggunakan pekali kekasaran Manning sebanyak 0.012, kirakan keperluan kecerunan dasar paip untuk memastikan aliran yang diperlukan dikekalkan serta mencapai keupayaan pembersihan diri paip tersebut.

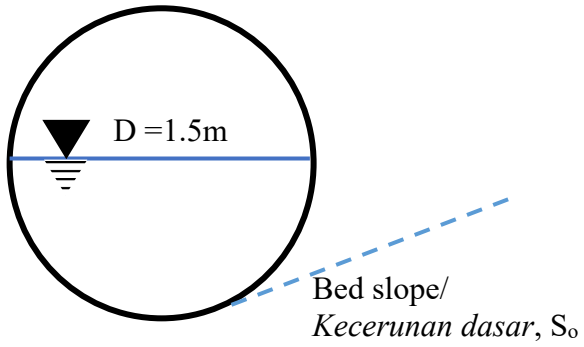


Figure B1(b) / *Rajah B1(b)*

[9 marks]
[*9 markah*]

CLO 2 (c) As a developer, it is important to design channels effectively to reduce the risk of overflow or erosion in urban drainage systems. Calculate the minimum cross-sectional area of a trapezoidal open channel, as shown in Figure B1(c) required to handle a flow rate of 8.5 m^3/s, assuming a Manning's roughness coefficient of 0.015. The channel has a bed slope of 1/1100 and side slope of 1V:2H.

Sebagai seorang pemaju, adalah penting untuk mereka bentuk saluran dengan berkesan bagi mengurangkan risiko limpahan atau hakisan dalam sistem saliran bandar. Kira luas keratan rentas minimum bagi saluran terbuka berbentuk trapezoid seperti yang ditunjukkan dalam Rajah B1(c) yang diperlukan untuk menampung kadar aliran 8.5 m^3/s, dengan pekali kekasaran Manning sebanyak 0.015. Saluran tersebut mempunyai kecerunan dasar 1/1100 dan kecerunan sisi 1V:2H.

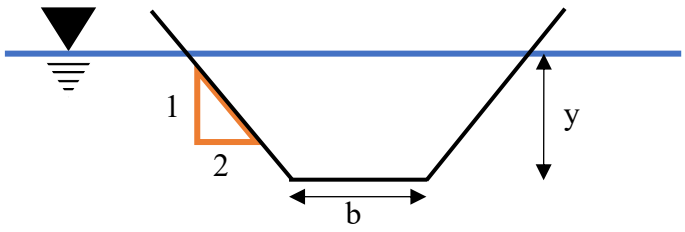


Figure B1(c) / *Rajah B1(c)*

[12 marks]

[*12 markah*]

QUESTION 2

SOALAN 2

CLO2 (a) With the aid of a diagram, explain uniform flow in an open channel showing the water depth (y), velocity (V) and channel bed slope (S_o).

Dengan bantuan gambar rajah, terangkan aliran seragam dalam saluran terbuka yang menunjukkan kedalaman air (y), halaju (V) dan cerun dasar saluran (S_o).

[4 marks]

[*4 markah*]

CLO2 (b) Water flowing in a rectangular open channel with a bottom slope of 1:3000 and Manning coefficient, n = 0.015. Determine the most economical dimension of the channel if this channel needs to deliver water at a flow rate of $0.025m^3/s$.

Air yang mengalir dalam saluran terbuka segi empat tepat dengan kecerunan bawah 1:3000 dan pekali Manning, n = 0.015. Tentukan dimensi saluran yang paling menjimatkan jika saluran ini perlu menghantar air pada kadar aliran $0.025m^3/s$.

[9 marks]

[*9 markah*]

CLO2 (c) A trapezoidal channel as shown in Figure B2(c), has a side slope of 2V:3H carry a flow rate of $20m^3/s$ of water. If the bed slope is 1 in 1200 and the Manning coefficient is n = 0.014 for a vitrified clay channel, calculate the best economical hydraulic cross-section of the channel.

Saluran trapezoid seperti yang ditunjukkan dalam Rajah B2(c), mempunyai kecerunan sisi 2V:3H perlu membawa kadar aliran $20m^3/s$ air. Jika kecerunan dasar ialah 1 dalam 1200 dan pekali Manning ialah n = 0.014 untuk saluran tanah liat yang divitrifikasi, kirakan keratan rentas hidraulik ekonomi terbaik saluran tersebut.

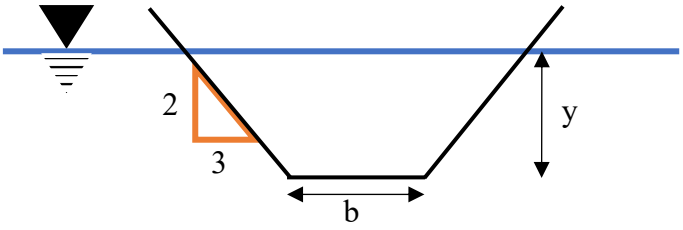


Figure B2(c) / *Rajah B2 (c)*

[12 marks]

[*12 markah*]

QUESTION 3
SOALAN 3

CLO2 (a) Describe the Froude number and its types of flow in an open channel.
Jelaskan nombor Froude dan jenis-jenis alirannya dalam saluran terbuka.

[4 marks]
[*4 markah*]

CLO2 (b) A rectangular channel with a width of 3.25 m discharges 2600 liters of water per second. Determine the critical depth, critical velocity and minimum specific energy.

Saluran segi empat dengan lebar 3.25 m mengalirkan 2600 liter air setiap saat. Tentukan kedalaman kritikal, halaju kritikal dan tenaga tentu minima.

[9 marks]
[*9 markah*]

CLO2 (c) Water is flowing non-uniformly through a rectangular channel with a width of 3 m at a rate of 9.72 m^3/s. If the depth of flow is 0.8 m, calculate the depth of flow after the jump, the height of the hydraulic jump, and the energy loss due to the hydraulic jump.

Air mengalir secara tidak seragam melalui saluran segi empat tepat dengan lebar 3 m pada kadar 9.72 m^3/s. Jika kedalaman aliran adalah 0.8 m, kirakan kedalaman aliran selepas lompatan, ketinggian lompatan hidraulik, dan kehilangan tenaga akibat lompatan hidraulik.

[12 marks]
[*12 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) Explain subcritical flow and supercritical flow in an open channel.

Terangkan aliran subkritikal dan aliran superkritikal dalam saluran terbuka.

[4 marks]

[*4 markah*]

CLO2 (b) Water flows through a rectangular channel 4 m wide at a rate of 12 m^3/s, with a depth of 1.6 m. Compute the critical depth, critical velocity and minimum specific energy head.

Air mengalir melalui saluran segi empat tepat selebar 4 m pada kadar 12 m^3/s, dengan kedalaman 1.6 m. Hitungkan kedalaman kritikal dan tenaga tentu minimum.

[9 marks]

[*9 markah*]

CLO2 (c) A 3.55 m wide rectangular open channel carries water at 21.50 m^3/s with a velocity of 10.35 m/s. Determine the specific energy, water depth at minimum specific energy, minimum specific energy and type of flow.

Saluran terbuka segi empat tepat selebar 3.55 m mengalirkan air pada kadar 21.50 m^3/s dengan halaju 10.35 m/s. Tentukan tenaga tentu, kedalaman air pada tenaga tentu minimum, tenaga tentu minimum, dan jenis aliran.

[12 marks]

[*12 markah*]

SOALAN TAMAT

FORMULA DCC50222: HYDRAULICS

HYDROSTATIC FORCE

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

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

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

$$F_V = \rho g V$$

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

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

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

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

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

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

$$F_R = F_1 + F_2 + F_3$$

$$F_R = F_1 - F_2$$

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

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

BUOYANCY AND FLOATATION

$$W = \rho_b g V_b$$

$$F_B = \rho_f g V_d$$

$$BG = OG - OB$$

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

$$GM = BM - BG$$

UNIFORM OPEN CHANNEL

$$Q = Av$$

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

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

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

Best hydraulics cross section

Rectangular

$$b = 2y$$

Trapezoidal

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

Circular

$$r = y$$

NON-UNIFORM OPEN CHANNEL

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

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

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

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

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

$$\Delta y = y_2 - y_1$$

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

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

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

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

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

$$P = \rho Q g E_L$$

Table A1: *Geometric Properties of Plane Surface*

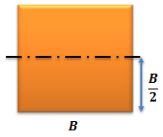
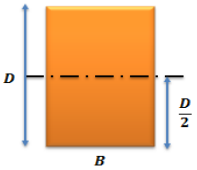
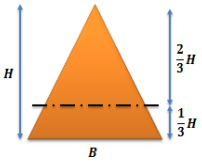
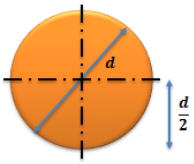
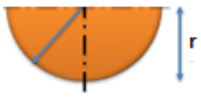
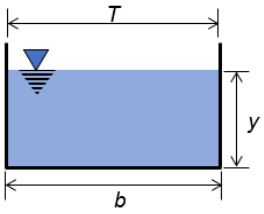
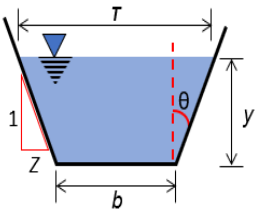
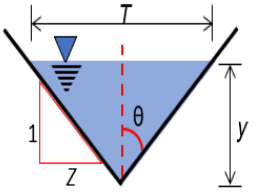
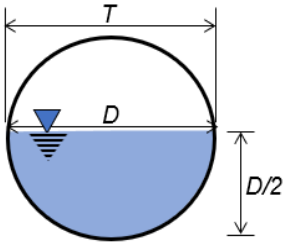
	Square	Rectangle	Triangle	Circle	Semi-circle
Shape					
Area	$A = B^2$	$A = BD$	$A = \frac{1}{2} BH$	$A = \frac{\pi d^2}{4}$	$A = \frac{\pi r^2}{2}$
I_c	$I_c = \frac{B^4}{12}$	$I_c = \frac{BD^3}{12}$	$I_c = \frac{BH^3}{36}$	$I_c = \frac{\pi d^4}{64}$	$I_c = 0.1102r^4$

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 	$A = y(b + zy)$	$P = b + 2y\sqrt{1 + z^2}$	$T = b + 2zy$
	$A = y[b + (\tan\theta)y]$	$P = b + \frac{2y}{\cos\theta}$	$T = b + 2(\tan\theta)y$
Triangular 	$A = y(zy)$	$P = 2y\sqrt{1 + z^2}$	$T = 2zy$
	$A = y[(\tan\theta)y]$	$P = \frac{2y}{\cos\theta}$	$T = 2(\tan\theta)y$
Semi-circular 	$A = \frac{\pi r^2}{2}$	$P = \pi r$	$T = 2r$
	$A = \frac{\pi D^2}{8}$	$P = \frac{\pi D}{2}$	$T = D$