



**KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI**

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI II : 2025/2026

DJJ30103 : STRENGTH OF MATERIALS

TARIKH : 07 MEI 2026

MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEPULUH (10)** halaman bercetak.

Struktur (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) Explain the terms stress and strain including their formulas and units in each term.

Terangkan istilah tegasan dan terikan bersama definisi, rumus dan unit bagi istilah masing-masing.

[6 marks]

[6 markah]

CLO1

- (b) A composite bar is fixed in series with 120 cm of steel bar and 40 cm of brass bar. A cross sectional area of steel bar is 900 mm^2 and brass bar is 345 mm^2 . The axial load of 100 kN is applied to the bar. Given $E_{\text{steel}} = 200 \text{ GN/m}^2$ and $E_{\text{brass}} = 100 \text{ GN/m}^2$. Calculate :

Sebuah bar dipasang secara bersiri dengan bar keluli 120 cm dan bar loyang 40 cm. Luas keratan rentas bar keluli ialah 900 mm^2 dan loyang ialah 345 mm^2 . Beban paksi 100 kN dikenakan pada bar komposit. Diberi $E_{\text{steel}} = 200 \text{ GN/m}^2$ and $E_{\text{brass}} = 100 \text{ GN/m}^2$. Kirakan :

- i. the elongation of the steel composite bar.
nilai bagi perubahan panjang bar komposit keluli.

[3 marks]

[3 markah]

- ii. the elongation of the brass composite bar
nilai bagi perubahan panjang bar komposit tembaga
- [3 marks]
[3 markah]
- iii. the value of the total elongation for both composite bar
nilai bagi jumlah perubahan panjang bagi kedua-dua bar komposit
- [3 marks]
[3 markah]

CLO1

- (c) The **Figure 1(c)** shows a composite bar rigidly fixed at both ends. Take into consideration that the temperature is increased by 60°C .

Rajah 1(c) menunjukkan satu bar majmuk yang dipasang secara tegar pada kedua-dua hujungnya. Andaikan suhu naik sebanyak 60°C .

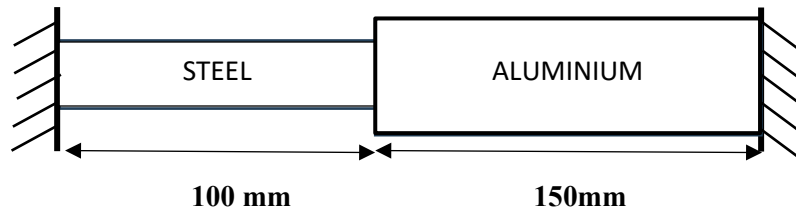


Figure 1 (c) / Rajah 1 (c)

Given,

Diberi

$$E_{\text{steel}} = 200 \text{ GN/m}^2 \quad \alpha_{\text{steel}} = 12 \times 10^{-6} / ^{\circ}\text{C} \quad A_{\text{steel}} = 100 \text{ mm}^2$$

$$E_{\text{Aluminium}} = 70 \text{ GN/m}^2 \quad \alpha_{\text{Aluminium}} = 24 \times 10^{-6} / ^{\circ}\text{C} \quad A_{\text{Aluminium}} = 250 \text{ mm}^2$$

- i. Calculate the thermal expansion, x

Kirakan pengembangan haba, x

[3 marks]

[3 markah]

- ii. Calculate the force that occurs in steel and aluminium composite bar

Kirakan tegasan pada bar komposit keluli dan aluminium

[7 marks]

[7 markah]

QUESTION 2:**SOALAN 2**

CLO1

- (a) Visualize **THREE (3)** types of simply supported beam with the Free Body Diagram (FBD) for each beam.

*Gambarkan **TIGA (3)** jenis rasuk yang disokong mudah beserta Gambarajah Badan Bebas (FBD) bagi setiap rasuk.*

[6 marks]

[6 markah]

CLO1

- (b) A beam shown in **Figure 2 (b)** is subjected with uniform distributed load and concentrated load.

*Satu rasuk seperti dalam **Rajah 2 (b)** dikenakan beban teragih seragam dan beban tumpu.*

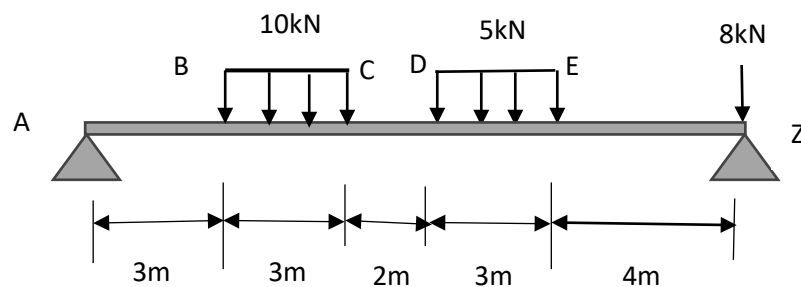


Figure 2 (b) / Rajah 2 (b)

- i. Sketch the Free Body Diagram (FBD)

Lakarkan gambarajah badan bebas (FBD)

[2 marks]

[2 markah]

CLO1

- ii. Calculate shear force value along the beam

Kirakan nilai daya ricih sepanjang rasuk

[6 marks]

[6 markah]

- c) Bending moment diagram is a graph that shows the reaction of the moment in the beam that can relate to the shear force based on **Figure 2 (b)**.

*Rajah momen lentur adalah graf yang menunjukkan tindak balas momen sepanjang rasuk dan boleh dikaitkan dengan daya ricih berdasarkan **Rajah 2 (b)**.*

- i. Calculate the bending moment value along the beam and sketch bending moment diagram.

Kirakan nilai momen lentur sepanjang rasuk dan lakar gambarajah momen lentur .

[8 marks]

[8 markah]

- ii. State the maximum bending moment point and its position

Nyatakan kedudukan titik momen lentur maksimum dan kedudukannya

[3 marks]

[3 markah]

QUESTION 3**SOALAN 3**

CLO2

- (a) Based on the equation below, name **FIVE (5)** symbols and its unit.
*Berdasarkan persamaan di bawah, namakan **LIMA (5)** simbol dan unitnya.*

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

[5 marks]

[5 markah]

CLO2

- (b) **Figure 3(b)** shows the cross-sectional area of the simply supported beam. Calculate:
Rajah 3(b) menunjukkan keratan rentas bagi satu rasuk sokongan mudah. Kirakan;

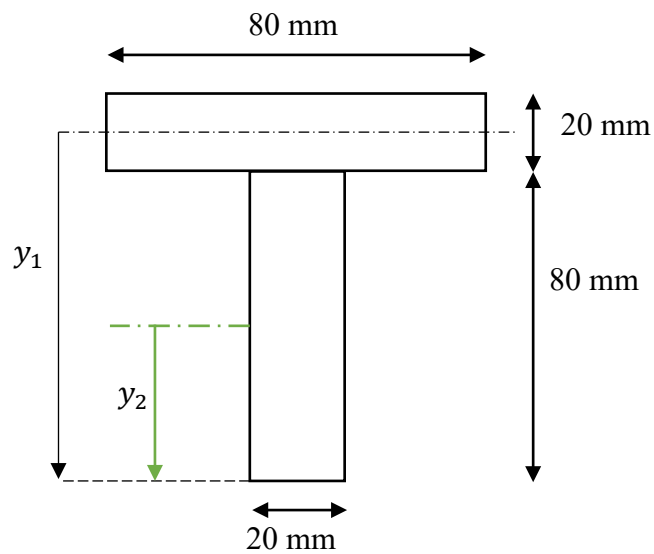


Figure 3(b) / Rajah 3(b)

- i. Natural axis
Paksi neutral

[6 marks]

[6 markah]

- ii. Second moment of area.
Momen luas kedua

[6 marks]

[6 markah]

CLO2

- (c) A 5m long simply supported beam is given a point load of 25 kN at the middle of the beam.

Given $E = 190 \text{ GN/m}^2$ and $I = 13.5 \times 10^{-6} \text{ m}^4$

Sebatang rasuk disokong mudah sepanjang 5 m dikenakan beban tumpu sebanyak 25 kN di pertengahan rasuk.

Diberi : $E = 190 \text{ GN/m}^2$ dan $I = 13.5 \times 10^{-6} \text{ m}^4$

- i. Sketch the Free Body Diagram (FBD).

Lakarkan gambar rajah jasad bebas (FBD).

[2 marks]

[2 markah]

- ii. Determine the maximum deflection of the beam if the load were reduced by 20%.

Tentukan pesongan maksimum bagi rasuk sekiranya beban tumpu berkurang 20%.

[6 marks]

[6 markah]

QUESTION 4**SOALAN 4**

CLO2

- (a) State the terms and unit for each symbol below.

Nyatakan terma dan unit bagi setiap symbol di bawah.

$$\frac{G\theta}{L} = \frac{T}{J}$$

[5 marks]

[5 markah]

CLO2

- (b) A copper shaft has a diameter of 55 mm and 65 cm long has applied torque of 2.85 kNm. Given
- $G_{\text{copper}} = 40 \text{ GN/m}^2$
- .

Aci kuprum dengan diameter 55 mm dan 65 cm panjang dikenakan daya kilas 2.85 kNm. Diberi $G_{\text{copper}} = 40 \text{ GN/m}^2$

- i. Calculate the value of second polar moment of area.

Kirakan nilai polar moment luas kedua.

[2 marks]

[2 markah]

- ii. Calculate the shear stress value.

Kirakan nilai tegasan ricih melalui pengiraan.

[3 marks]

[3 markah]

- iii. Calculate the twisting angle of the shaft due to applied torque.

Kirakan sudut piuh aci yang disebabkan oleh daya kilas.

[3 marks]

[3 markah]

CLO2

- (c) A solid shaft with a length of 3.4 m at speed of 205 rpm transmits 7 MW of power. The shaft has a maximum allowable twisting angle is 4° .

Given; $G=80$ GPa.

Aci padu sepanjang 3.4 m berkelajuan 205 rpm memindahkan kuasa 7 MW.

Sudut piuh maksimum aci adalah is 4° . Diberi; $G=80$ GPa.

- i. Change the unit for angle of twist to radian

Tukarkan unit sudut piuh kepada radian

[2 marks]

[2 markah]

- ii. Calculate the torque of the shaft.

Kirakan daya kilas aci

[4 marks]

[4 markah]

- iii. Calculate the second polar moment of area

Kirakan polar moment luas kedua

[3 marks]

[3 markah]

- iv. Calculate the diameter of shaft

Kirakan diameter aci

[3 marks]

[3 markah]

SOALAN TAMAT

FORCES ON MATERIALS

$$P = \sigma A \quad \sigma = \varepsilon E$$

$$v = \frac{\varepsilon_y}{\varepsilon_x} \quad S.F = \frac{\sigma_{ult}}{\sigma_w}$$

$$\% \Delta L = \frac{L_f - L_o}{L_o} \times 100\%$$

$$\% A = \frac{A_o - A_f}{A_o} \times 100\%$$

THERMAL STRESS AND COMPOSITE BAR

$$\Delta L = \frac{PL}{AE} = \frac{\sigma L}{E}$$

$$\Delta L = \alpha L \Delta t \quad \sigma = E \alpha \Delta t$$

Subjected to force:

Series

$$P_1 = P_2$$

$$\Sigma \Delta L = \Delta L_1 + \Delta L_2$$

Parallel

$$P = P_1 + P_2$$

$$\Delta L_1 = \Delta L_2$$

Subjected to temperature:

Series

$$\frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 E_2} = \Delta t (\alpha_1 L_1 + \alpha_2 L_2)$$

Parallel

$$\frac{\sigma_1}{E_1} + \frac{\sigma_2}{E_2} = \Delta t (\alpha_b - \alpha_k)$$

SHEAR FORCE AND BENDING MOMENT

$$\Sigma F \uparrow = \Sigma F \downarrow$$

$$Force = wL \text{ (unit: N)}$$

$$\Sigma M \curvearrowright = \Sigma M \curvearrowleft$$

$$Moment = Fd \text{ (unit: Nm)}$$

TORSION

$$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$$

$$P = T\omega$$

$$\omega = \frac{2\pi N}{60}$$

$$J = \frac{\pi d^4}{32}$$

Series compound

$$T_1 = T_2$$

$$\frac{G_1 \theta_1 J_1}{L_1} = \frac{G_2 \theta_2 J_2}{L_2}$$

$$\Sigma \theta = \theta_1 + \theta_2$$

Parallel compound

$$T = T_1 + T_2$$

$$\theta_1 = \theta_2$$

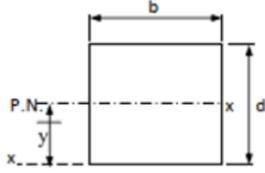
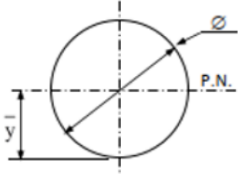
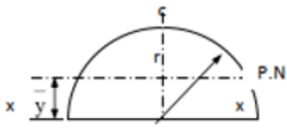
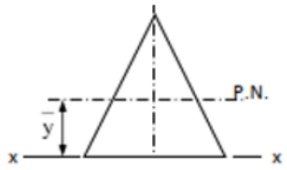
$$\frac{T_1 L_1}{G_1 J_1} = \frac{T_2 L_2}{G_2 J_2}$$

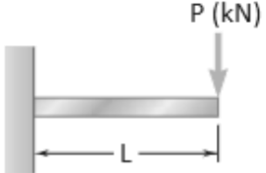
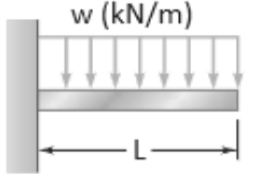
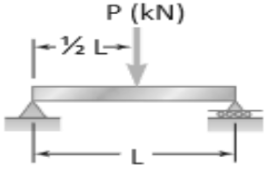
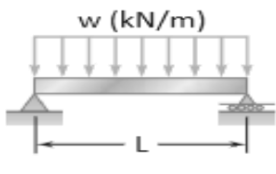
BENDING STRESS AND BEAM DEFLECTION

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A}$$

$$I_{NA} = \Sigma(I + Ah^2)$$

Shape	Centroid, y	Second Moment of Area, I
	$y = \frac{d}{2}$	$I_{NA} = \frac{bd^3}{12}$
	$y = \frac{d}{2}$	$I_{NA} = \frac{\pi d^4}{64}$
	$y = \frac{4r}{3\pi}$	$I_{NA} = 0.11r^4$
	$y = \frac{h}{3}$	$I_{NA} = \frac{bh^3}{36}$

Beam	Moment, $M_{\max}$	Slope, $\theta_{\max}$	Deflection, $y_{\max}$
	PL	$-\frac{PL^2}{2EI}$	$-\frac{PL^3}{3EI}$
	$\frac{wL^2}{2}$	$-\frac{wL^3}{6EI}$	$-\frac{wL^4}{8EI}$
	$\frac{PL}{4}$	$\pm \frac{PL^2}{16EI}$	$-\frac{PL^3}{48EI}$
	$\frac{wL^2}{8}$	$\pm \frac{wL^3}{24EI}$	$-\frac{5wL^4}{384EI}$