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 MEKANIKAL

PEPERIKSAAN AKHIR

SESI I : 2025/2026

DJJ30103: STRENGTH OF MATERIALS

TARIKH : 05 DISEMBER 2025
MASA : 08.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) Explain the static load, dynamic load, and impact load, each with **ONE (1)** example.

*Terangkan beban statik, beban dinamik, beban hentaman bersama **SATU (1)** contoh.*

[6 marks]

[6 *markah*]

CLO1 (b) A composite bar, consisting of Aluminium at PQ and Copper at QR are subjected to compressive load of 85 kN as illustrated in Figure 1(b). If PQ bar has diameter of 55 mm and QR bar has diameter of 75 mm, calculate;

Sebatang bar komposit yang terdiri daripada aluminium pada bahagian PQ dan tembaga pada bahagian QR dikenakan beban mampatan sebanyak 85 kN seperti yang ditunjukkan dalam Rajah 1(b). Jika bar PQ mempunyai diameter 55 mm dan bar QR mempunyai 75 mm, hitungkan :

Given :

Diberi:

$E_{Al} = 75GN/m^2$

$E_{Cu} = 120GN/m^2$

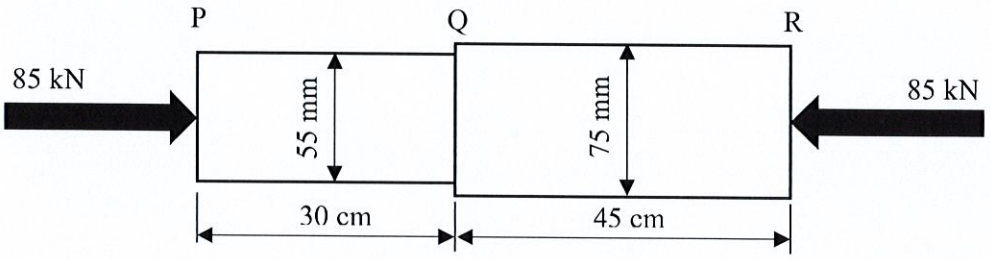


Figure 1(b) / *Rajah 1(b)*

i. stress in both bars
tegasan di dalam kedua-dua bar

[5 marks]
[*5 markah*]

ii. total elongation of the composite bar
jumlah perubahan pemanjangan bar komposit

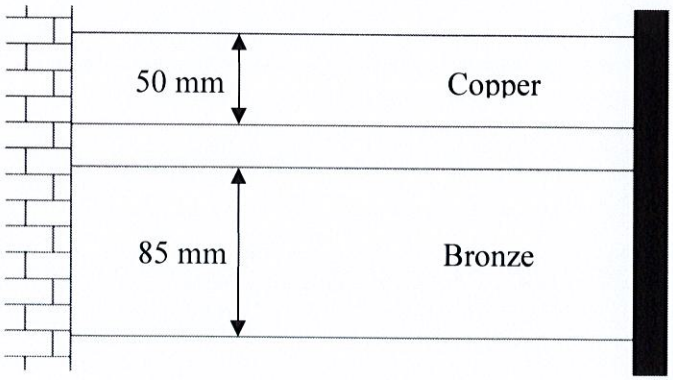
[4 marks]
[*4 markah*]

CLO1 (c) A composite parallel bar is made of **TWO (2)** bars, that are bronze and copper with an initial temperature of 25 °C as shown in Figure 1(c) below. The copper diameter is 50 mm and 85 mm for bronze. The bar was rigidly fixed at both ends. Calculate the stress in each bar when the temperature is risen to 75 °C;
*Sebatang bar komposit selari terdiri daripada **DUA (2)** batang iaitu gangsa dan kuprum dengan suhu awal 25 °C, seperti yang ditunjukkan dalam Rajah 1(c) di bawah. Diameter batang kuprum ialah 50 mm dan 85 mm untuk gangsa. Palang tersebut diikat secara kaku pada kedua-dua hujungnya. Hitung tegasan dalam setiap bar apabila suhu dinaikkan kepada 75 °C;*

Given :
Diberi:

$E_{Bz} = 102 GN/m^2$ $\alpha_{Bz} = 21.6 \times 10^{-6}/°C$

$E_{Cu} = 90 GN/m^2$ $\alpha_{Cu} = 17.0 \times 10^{-6}/°C$



[10 marks]
[*10 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Explain overhanging and cantilever beams with definitions and diagrams.

Terangkan rasuk juntai dan rasuk julur dengan definisi dan rajah.

[6 marks]

[*6 markah*]

CLO1 (b) A simple supported beam is carrying a load as shown in Figure 2(b) below,

Sebatang rasuk disokong mudah menanggung beban seperti yang ditunjukkan dalam Rajah 2(b) di bawah.

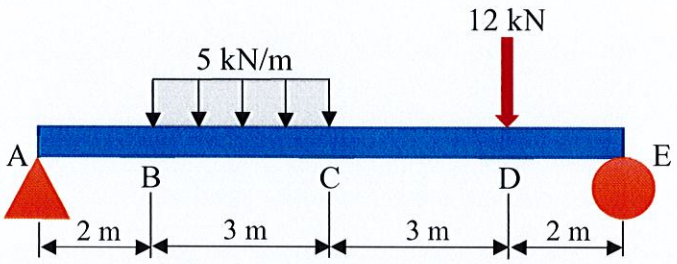


Figure 2(b) / *Rajah 2(b)*

i) Calculate the reaction force

Kira daya tindak balas

[3 marks]

[3 *markah*]

ii) Sketch shear force diagram for the beam.

Lakarkan gambarajah daya ricih bagi rasuk

[5 marks]

[5 *markah*]

CLO1

(c) Referring to the shear force diagram in Figure 2 (b), calculate:
Merujuk kepada rajah daya ricih dalam Rajah 2(b), hitung:

i. the bending moment value and sketch the Bending Moment Diagram
nilai momen lentur dan lakarkan Rajah Momen Lentur

[9 marks]
[9 *markah*]

ii. the maximum bending moment and its position
momen lentur maksimum dan kedudukannya

[2 marks]
[2 *markah*]

QUESTION 3

SOALAN 3

CLO2 (a) Based on the following equation for bending stress, define the meaning of five symbols and its units.

Berdasarkan persamaan tegasan lenturan yang berikut, jelaskan makna lima simbol dan unitnya.

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

[5 marks]

[*5 markah*]

CLO2 (b) A composite beam, 9 m long as depicted in Figure 3(b), is simply supported at both ends *A* and *B*.

Sebatang rasuk komposit, sepanjang 9 m seperti yang ditunjukkan dalam Rajah 3(b), disokong secara mudah di kedua-dua hujung A dan B.

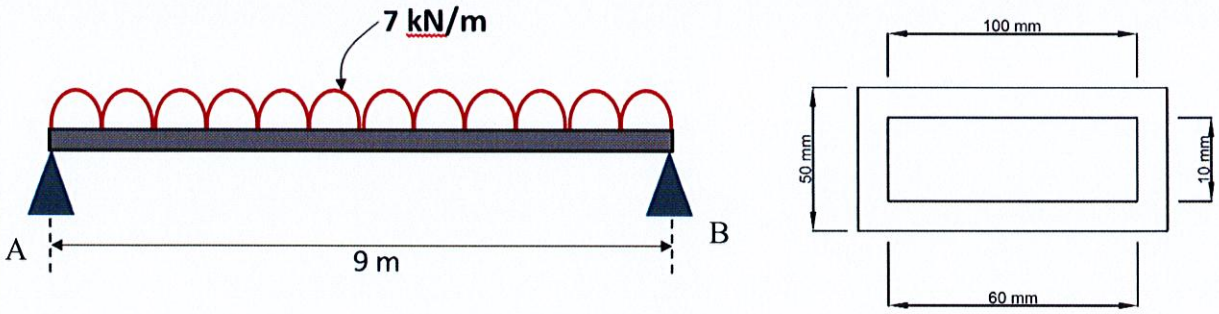


Figure 3(b) / *Rajah 3(b)*

Calculate the following:

Kirakan yang berikut:

i. Centroid of the beam section about the neutral axis.

Pusat graviti bagi keratan rasuk pada paksi neutral.

[2 marks]

[*2 markah*]

ii. Moment of inertia of the beam section about the neutral axis.
Momen inersia bagi keratan rasuk pada paksi neutral.

[4 marks]
[*4 markah*]

iii. Maximum bending stress of the beam.
Tegasan lentur maksimum bagi rasuk.

[6 marks]
[*6 markah*]

CLO2 (c) A cantilever beam 3 m long is subjected to a uniformly distributed load of 200 kN/m as illustrated in Figure 3(c). Given the Young's modulus of 483 GN/m^2 and the second moment of area of 6.21×10^{-5} m^4. Determine:
Sebatang rasuk cantilever sepanjang 3 m terdedah kepada beban teragih seragam sebanyak 200 kN/m seperti yang ditunjukkan dalam Rajah 3(c). Diberi modulus Young, $E = 483$ GN/m^2 dan momen kedua kawasan, $I = 6.21\times10^{-5}$ m^4. Tentukan:

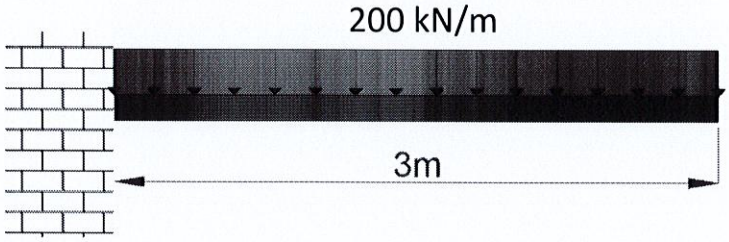


Figure 3(c) / *Rajah 3(c)*

i. the deflection of the beam.
pesongan rasuk.

[4 marks]
[*4 markah*]

ii. the slope at the free end of the beam.
kecerunan di hujung bebas rasuk.

[4 marks]
[*4 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) State **FIVE (5)** symbols below with their units.

*Nyatakan **LIMA (5)** simbol di bawah dengan unit.*

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

[5 marks]

[*5 markah*]

CLO2 (b) With the aid of diagram, explain the equation and its corresponding units used to calculate the polar moment of inertia for the cross sections of;

Berdasarkan gambarajah yang berkaitan, terangkan persamaan dan unit yang sepadan yang digunakan untuk mengira momen inersia kutub bagi keratan rentas;

i. Solid rod

Rod padu.

[4 marks]

[4 *markah*]

ii. Hollow rod

Rod berongga

[4 marks]

[*4 markah*]

CLO2

(c) Figure 4(c) depicts steel bar with a diameter of 50 mm and a length of 0.5 m connected in series to a copper bar. The copper bar has same diameter with steel bar and their length of 0.75 m. Both the bar carries a torsional load of 250 Nm. Consider the modulus of rigidity for G_{copper} is 45 GN/m^2 and G_{steel} is 78 GN/m^2. Compute:

Rajah 4(c) menunjukkan sebatang rod keluli dengan diameter 50 mm dan panjang 0.5 m yang disambung secara siri dengan sebatang rod kuprum. Rod kuprum tersebut mempunyai diameter yang sama dengan rod keluli dan panjangnya ialah 0.75 m. Kedua-dua rod menanggung beban kilasan sebanyak 250 Nm. Ambil kira modulus kekakuan G_{kuprum} ialah 45 GN/m² dan G_{keluli} ialah 78 GN/m². Kirakan:

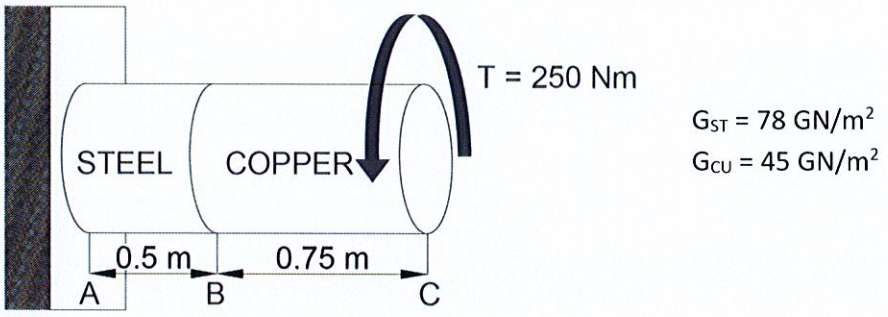


Figure 4(c) / *Rajah 4(c)*

i. The value of second polar moment of area of each bar.
Nilai momen luas kutub kedua bagi setiap rod.

[4 marks]
[*4 markah*]

ii. The angle of twist for each bar.
Sudut kilasan bagi setiap rod.

[5 marks]
[*5 markah*]

iii. The total angle of twist developed by the compound bar.
Jumlah sudut kilasan yang dihasilkan oleh bar gabungan.

[3 marks]
[*3 markah*]

SOALAN TAMAT

DJJ30103: STRENGTH OF MATERIALS

FORCES ON MATERIALS

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

$$\upsilon = \frac{\varepsilon_y}{\varepsilon_x} \qquad S.F = \frac{\sigma_{ult}}{\sigma_w}$$

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

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

THERMAL STRESS AND COMPOSITE BAR

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

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

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

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

$$Force = wL\ (unit: N)$$

$$\Sigma M \circlearrowright = \Sigma M \circlearrowleft$$

$$Moment = Fd\ (unit: Nm)$$

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

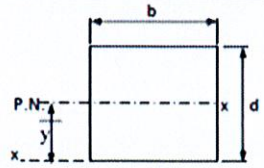
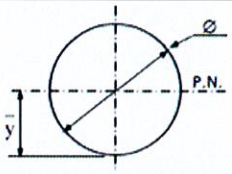
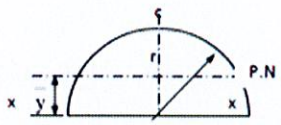
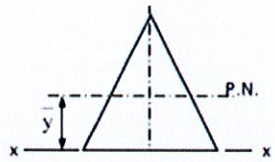
$$T = T_1 + T_2$$

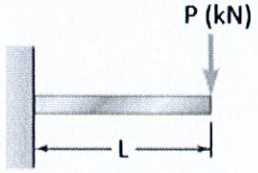
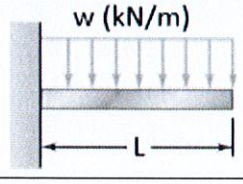
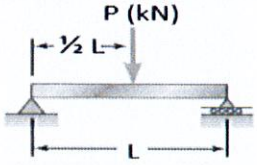
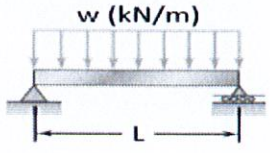
$$\theta_1 = \theta_2$$

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

BENDING STRESS AND BEAM DEFLECTION

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R} \qquad \bar{y} = \frac{\Sigma Ay}{\Sigma A} \qquad I_{NA} = \Sigma(I + Ah^2)$$

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