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 II : 2024/2025

DJJ30103 : STRENGTH OF MATERIALS

TARIKH : 14 MEI 2025
MASA : 8.30 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)** questions. Answers **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawap **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1

(a) Explain the following terms.

Terangkan istilah berikut.

i. Hooke's Law

Hukum Hooke

[2 marks]

[2 *markah*]

ii. Safety Factor

Faktor Keselamatan

[2 marks]

[2 *markah*]

iii. Poisson's Ratio

Nisbah Poisson

[2 marks]

[2 *markah*]

CLO1

(b) Figure 1(b) shows two copper rods and one steel rod together to support a weight of 300 kN. Given Young's Modulus for steel as 200 GPa and copper as 100 GPa. Calculate :

Rajah 1(b) menunjukkan dua batang tembaga dan satu batang keluli bersama-sama menyokong berat 300 kN. Diberi Modulus Young untuk keluli sebagai 200 GPa dan tembaga sebagai 100 GPa. Kirakan :

.

i. Force for steel and copper

Daya pada keluli dan tembaga

[7 marks]

[*7 markah*]

ii. Stress for steel and copper

Tegasan pada keluli dan tembaga

[2 marks]

[*2 markah*]

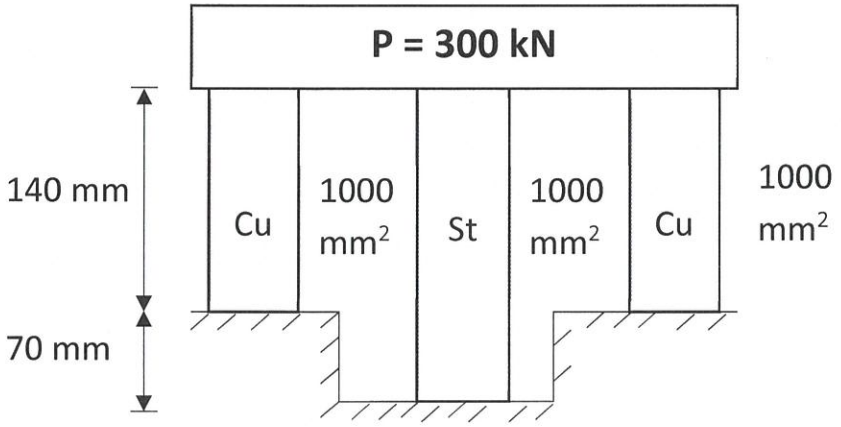


Figure 1(b) / *Rajah 1(b)*

CLO1

(c) Figure 1(c) below shows a composite bar made from aluminium and brass with a temperature of 40°C. Calculate the stress in each bar if the composite bar has been heated to 76°C. Given,

E_{alu}=69 GN/m^2, α_{alu} = 23x10^{-6}/°C

E_{br}=110 GN/m^2, α_{br} = 18.7x10^{-6}/°C

Rajah 1(c) di bawah menunjukkan sebuah bar komposit yang diperbuat daripada aluminium dan loyang dengan suhu 40 °C. Kirakan tegasan dalam setiap bar jika bar komposit telah dipanaskan hingga 76 °C. Diberi,

E_{alu}=69 GN/m^2, α_{alu} = 23x10^{-6}/°C

E_{br}=110 GN/m^2, α_{br} = 18.7x10^{-6}/°C

i. Area in aluminium and brass bar

Keluasan bar aluminium dan loyang

[2 marks]

[*2 markah*]

ii. Stress in aluminium and brass bar

Tegasan bar aluminium dan loyang

[8 marks]

[*8 markah*]

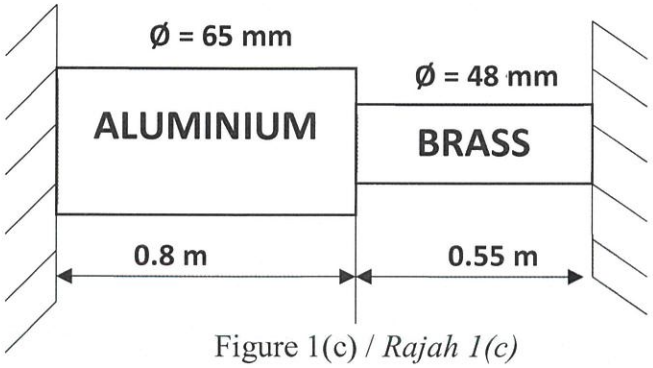


Figure 1(c) / *Rajah 1(c)*

QUESTION 2

SOALAN 2

CLO1 (a) Compare the following types of beams regarding the definition and diagram.
Bandingkan jenis rasuk di bawah berdasarkan definisi dan gambarajah.

i. Simply Supported Beam
Rasuk disokong mudah

[3 marks]
[*3 markah*]

ii. Cantilever Beam
Rasuk terjulur

[3 marks]
[*3 markah*]

CLO1 (b) A simply supported beam is loaded as shown in Figure 2(b) below. Calculate:
Satu rasuk disokong mudah dikenakan beban seperti ditunjukkan pada Rajah 2(b). Kirakan :

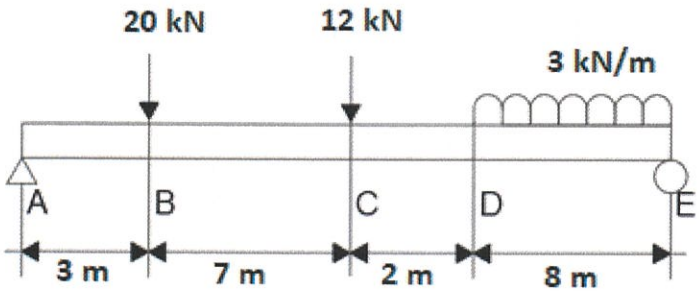


Figure 2(b) / *Rajah 2(b)*

i. Shear force and sketch the diagram along the beam.
Daya ricih dan lukiskan gambarajah daya ricih di sepanjang rasuk.

[8 marks]
[*8 markah*]

ii. Calculate bending moment along the beam and sketch the diagram
Kirakan momen lenturan sepanjang rasuk dan lukiskan gambar rajah

[8 marks]
[*8 markah*]

CLO1 (c) Value of maximum bending moment and its position.
Nilai momen lenturan maksimum dan kedudukannya.

[3 marks]
[*3 markah*]

QUESTION 3
SOALAN 3

CLO2 (a) Based on the equation below, name **FIVE (5)** of the following symbol and its unit:
*Berdasarkan persamaan di bawah, namakan **LIMA (5)** daripada simbol tersebut beserta unitnya:*

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

[5 marks]
[*5 markah*]

CLO2

b) Figure 3(b) shows the cross-sectional of the simply supported beam.
Rajah 3(b) menunjukkan keratan rentas bagi satu rusuk disokong mudah.

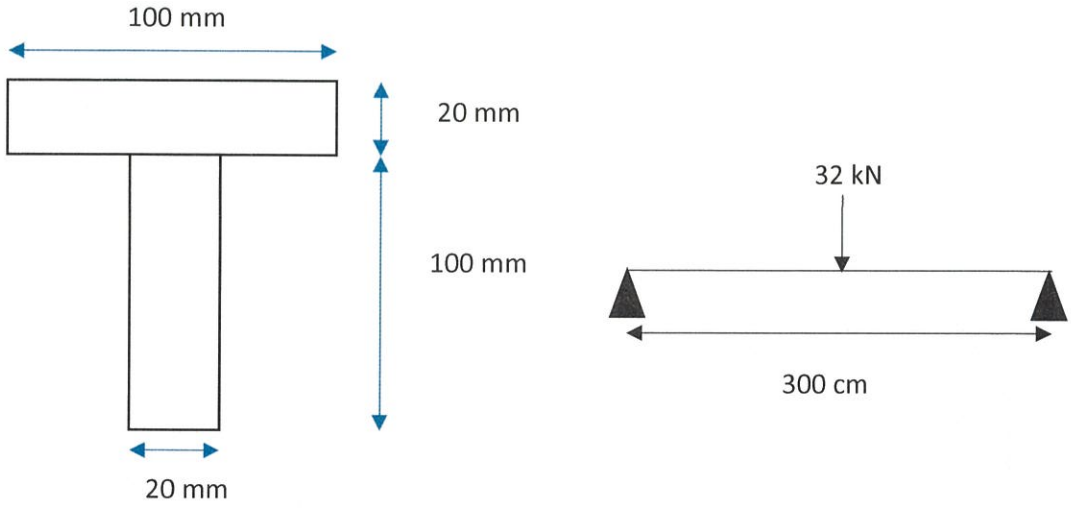


Figure 3(b) / *Rajah 3(b)*

Based on Figure 3(b), calculate:
Berdasarkan Rajah 3(b), kirakan:

i. Centroid.
centroid.

[3 marks]
[*3 markah*]

ii. second moment of area.
momen luas kedua.

[4 marks]
[*4 markah*]

iii. the maximum bending stress on beam.
tegasan lentur maksimum pada rasuk.

[5 marks]
[*5 markah*]

CLO2 (c) A 5 m long simply supported beam is given a point load of 30 kN in the middle of the beam. Given E = 190 GN/m^2 and I = 13.5x10^{-6} m^4. Determine:

Sebatang rasuk disokong mudah sepanjang 5 m dikenakan beban tumpu sebanyak 30 kN di pertengahan rasuk. Diberi E = 190 GN/m^2 dan I = 13.5x10^{-6} m^4. Tentukan:

i. the slope of the beam.
kecerunan rasuk.

[3 marks]
[*3 markah*]

ii. the maximum deflection of the beam if the load decreases by 20%.
pesongan maksimum rasuk sekiranya beban tumpu berkurang 20%.

[5 marks]
[*5 markah*]

QUESTION 4
SOALAN 4

CLO2 (a) Name any **FIVE (5)** symbols and its unit in the general torsion equation below.
*Namakan mana-mana **LIMA (5)** simbol beserta unitnya dalam persamaan umum kilasan di bawah.*

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

[5 marks]
[*5 markah*]

CLO2 (b) A steel hollow shaft with a length of 4 m and internal diameter of 150 mm with 5 mm thickness is subjected to a torque of 25 kNm. Use G = 160 GN/m^2. Express the value of:

Satu aci keluli berongga dengan panjang 4 m dan diameter dalam 150 mm dengan ketebalan 5 mm dikenakan daya kilas sebanyak 25 kNm. Gunakan G = 160 GN/m^2. Ungkapkan nilai:

i. the polar second moment of area of the shaft.
momen luas kedua kutub aci.

[4 marks]
[*4 markah*]

ii. the maximum shear stress of the shaft.
tegasan ricih maksimum aci.

[4 marks]
[*4 markah*]

CLO2 (c) A solid shaft with a length of 2.5 m at speed of 185 rpm transmits 6 MW of power. The maximum allowable twisting angle of the shaft is 3°. Calculate:
Aci padu yang panjangnya 2.5 m berkelajuan 185 rpm menghantar kuasa 6 MW. Sudut piuhan maksimum aci adalah 3°. Kirakan:

i. torque of the shaft, T
daya kilas aci, T

[4 marks]
[*4 markah*]

ii. second polar moment of area, J
momen luas kedua kutub, J

[4 marks]
[*4 markah*]

iii. diameter of shaft if value of G = 80 GPa.
diameter aci jika nilai G = 80 GPa.

[4 marks]
[*4 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

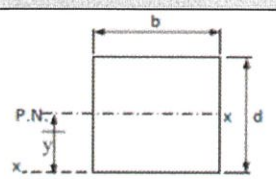
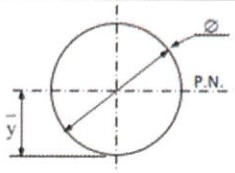
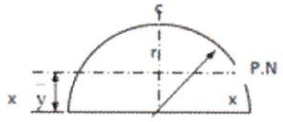
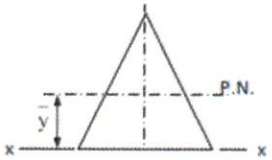
$$T = T_1 + T_2$$

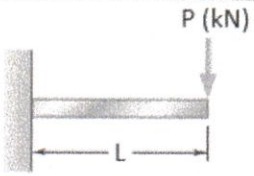
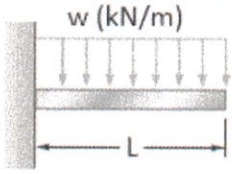
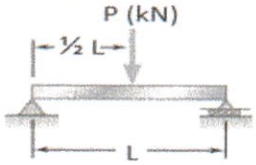
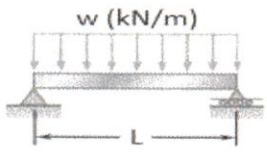
$$\theta_1 = \theta_2$$

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

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