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 : 2024/2025

DJJ30103: STRENGTH OF MATERIALS

TARIKH : 08 DISEMBER 2024
MASA : 11.30 PAGI – 1.30 PETANG (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)

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) Express the following:

i. **FIVE (5)** types of forces. [5 marks]

***LIMA (5)** jenis daya.* [*5 markah*]

ii. **ONE (1)** effect for each forces. [5 marks]

***SATU (1)** kesan bagi setiap daya.* [*5 markah*]

CLO1 (b) Aluminium bar with diameter and length of 15 mm and 875 mm is attached in series to a 30 mm x 30 mm square Steel bar, which has double of Aluminium's length. 25 kN of load is applied to the composite bar. Calculate:

Bar Aluminium dengan diameter dan panjang 15 mm dan 875 mm disambung secara siri pada bar Keluli persegi 30 mm x 30 mm yang mempunyai dua kali ganda panjang Aluminium. Beban 25 kN dikenakan pada bar komposit. Kirakan:

Given / *Diberi* $E_{Al} = 70$ GN/m^2 and $E_S = 210$ GN/m^2.

i. The area of both bar.

Luas kedua-dua bar.

[2 marks]

[*2 markah*]

ii. Total elongation of the composite bar.

Jumlah pemanjangan bar.

[5 marks]

[*5 markah*]

CLO1

(c) Figure 1(c) below shows a compound bar rigidly mounted at both end. Cross sectional area for steel and aluminium bar are 400 mm^2 and 335 mm^2. If the temperature is dropped by 23°C. Calculate:

Rajah 1(c) dibawah menunjukkan bar majmuk yang diikat dengan tegar di kedua-dua hujungnya. Luas keratan rentas bagi keluli dan aluminium masing-masing ialah 400 mm^2 dan 335 mm^2. *Jika suhu menurun sebanyak* 23°C. *Kirakan:*

Given */ Diberi:*

$E_S = 203\ GN/m^2$; $\alpha_S = 11.7 \times 10^{-6}/℃$

$E_A = 75\ GN/m^2$; $\alpha_A = 23.6 \times 10^{-6}/℃$

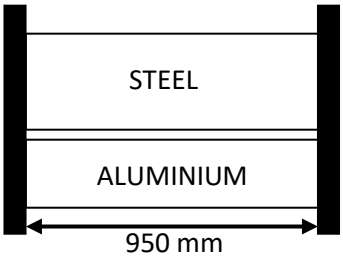


Figure 1 (c)/ *Rajah 1 (c)*

i. The total elongation of the bar.
Jumlah pemanjangan bar.

[3 marks]
[*3 markah*]

ii. The thermal stress developed in each bars.
Tegasan haba yang terbentuk dalam setiap bar.

[5 marks]
[*5 markah*]

QUESTION 2

SOALAN 2

A simple support beam is applied load as shown in Figure 2 below.

Sebatang rasuk disokong mudah dikenakan beban ditunjukkan pada Rajah 2 di bawah.

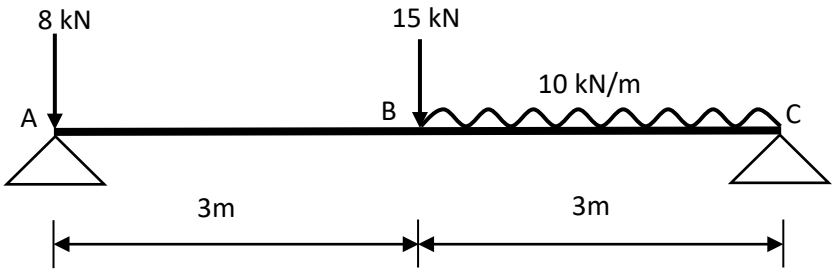


Figure 2 / *Rajah 2*

CLO1 (a) Express the value of reaction force with the aid of Free Body Diagram.
Nyatakan nilai daya tindakbalas dengan bantuan Gambarajah Badan Bebas.

[5 marks]
[*5 markah*]

CLO1 (b) Based on reaction force value:
Berdasarkan nilai daya tindak balas:

i. Calculate the shear force along the beam.
Kirakan daya ricih sepanjang rasuk.

[4 marks]
[*4 markah*]

ii. Sketch the shear force diagram.
Lakarkan gambarajah daya ricih.

[4 marks]
[*4 markah*]

CLO1

(c) Referring the shear force diagram:
Merujuk kepada gambarajah daya ricih:

i. Calculate the bending moment value.
Kirakan nilai momen lentur.

[4 marks]
[*4 markah*]

ii. Sketch the bending moment diagram.
Lakarkan gambarajah memon lentur.

[4 marks]
[*4 markah*]

iii. Show the value of maximum bending moment and its position in the diagram.
Tunjukkan nilai dan kedudukan momen lentur maksimum dalam Gambarajah.

[4 marks]
[*4 markah*]

QUESTION 3

SOALAN 3

CLO2 (a) Define the terms below:

Definisikan istilah-istilah dibawah:

i. Centroid.

Centroid.

[2 marks]

[*2 markah*]

ii. Second moment of area.

Momen luas kedua.

[2 marks]

[*2 markah*]

iii. Bending moment.

Momen lentur.

[2 marks]

[*2 markah*]

CLO2 (b) A cantilever T shape beam 400 mm long supports a load of 25 kN at the end of beam as illustrated in Figure 3(b). Calculate:

Sebatang rasuk julur bentuk T, 400 mm panjang menyokong beban 25 kN di hujung rasuk seperti dalam Rajah 3(b). Kirakan:

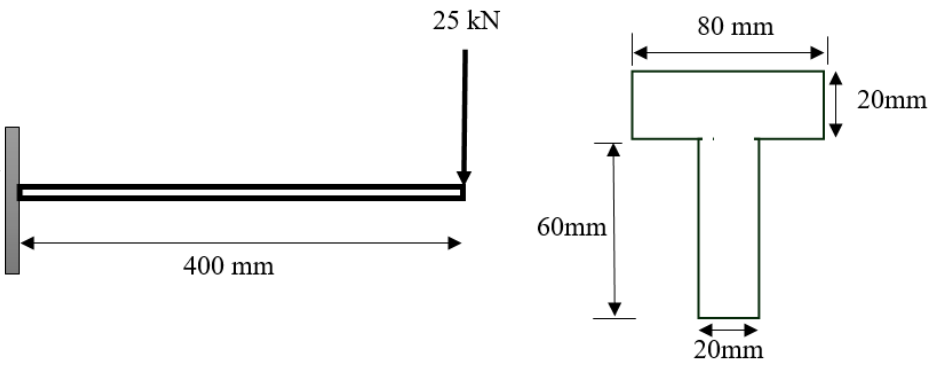


Figure 3(b) / *Rajah 3(b)*

i. Centroid of the T shape beam.
Centroid bagi rasuk bentuk T.

[3 marks]
[*3 markah*]

ii. Moment of inertia of the beam section.
Momen inersia bagi keratan rasuk.

[3 marks]
[*3 markah*]

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

[3 marks]
[*3 markah*]

CLO2

c) A 0.8 m long T shape beam supports a uniformly distributed load of 8 kN/m as illustrated in figure 3(c). Given the Young's Modulus, E = 80 GPa and the second moment of area, I = 1.51 x 10^{-6} m^4. Determine:
Sebatang rasuk berbentuk T panjangnya 0.8 m menyokong beban tak seragam sebanyak 8 kN/m seperti ditunjukkan dalam rajah 3(c). Diberi Modulus Young, E = 80 GPa dan Momen Luas Kedua, I = 1.51 x 10^{-6} m^4. Tentukan:

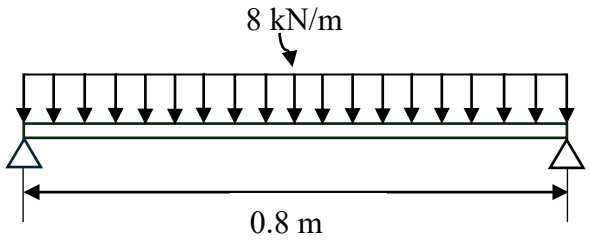


Figure 3(c) / *Rajah 3(c)*

i. The slope of the beam.
Kecerunan rasuk.

[5 marks]
[*5 markah*]

ii. New Young Modulus if the maximun deflection is 1.41×10^{-4}m.
Modulus Young jika pesongan maksimun adalah 1.41×10^{-4}m.

[5 marks]
[*5 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) State the terms and unit for each symbols below.

Nyatakan terma dan unit bagi setiap simbol dibawah.

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

[5 marks]

[*5 markah*]

CLO2 (b) A shaft with 60 mm diameter and 0.9 m long is subjected to a torque of 1300 Nm. Given G = 70GPa. Calculate:

Sebatang aci berdiameter 60 mm dan panjang 0.9 m dikenakan daya kilas sebanyak 1300 Nm. Diberi G = 70GPa. Kirakan:

i. The twist angle of shaft.

Sudut putaran bagi aci.

[5 marks]

[*5 markah*]

ii. The shear stress induced in the shaft.

Tegasan ricih yang terhasil dalam aci.

[3 marks]

[*3 markah*]

CLO2

(c) A 0.8 m long solid shaft is transmitting 70 kW power at 500 rpm. Determine:
Sebatang aci padu sepanjang 0.8 m memindahkan kuasa sebanyak 70 kW pada 500 ppm. Tentukan:

i. Total torque.
Jumlah daya kilas.

[3 marks]
[*3 markah*]

ii. The diameter of shaft if maximum shear stress is 150 MPa.
Diameter aci jika tegasan ricih maksimum adalah 150 MPa.

[5 marks]
[*5 markah*]

iii. Modulus of rigidity if the maximum twist angle allowed is 0.085 rad.
Modulus ketegaran jika sudut putaran adalah 0.085 rad.

[4 marks]
[*4 markah*]

END OF QUESTIONS
SOALAN TAMAT

FORCES ON MATERIALS

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

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

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

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

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

$P_1 = P_2$

$\Sigma \Delta L = L_1 + L_2$

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

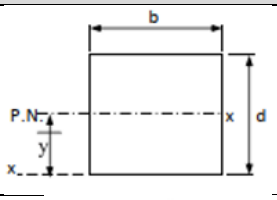
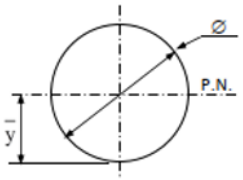
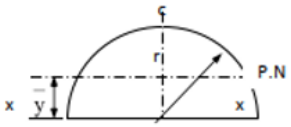
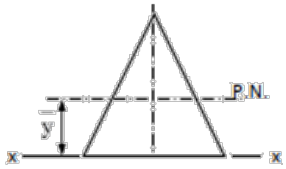
$T = T_1 + T_2$

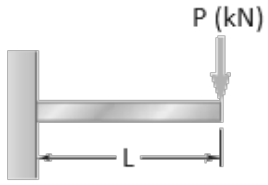
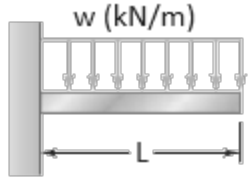
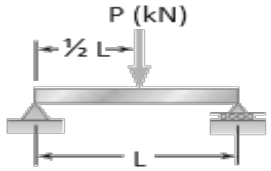
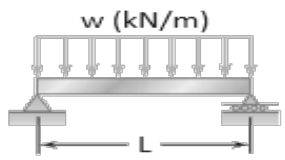
$\theta_1 = \theta_2$

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

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