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)**

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

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula

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**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:*

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

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

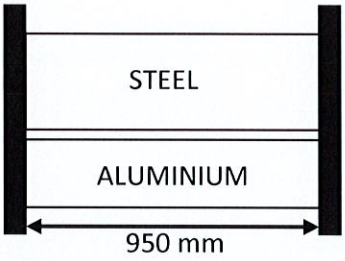



Figure 1 (c)/ *Rajah 1 (c)*

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.*

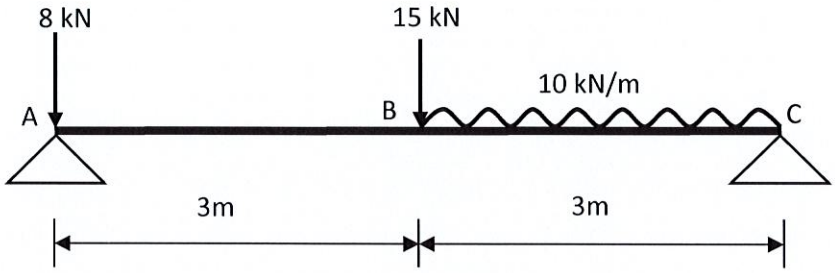



Figure 2 / *Rajah 2*

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:*

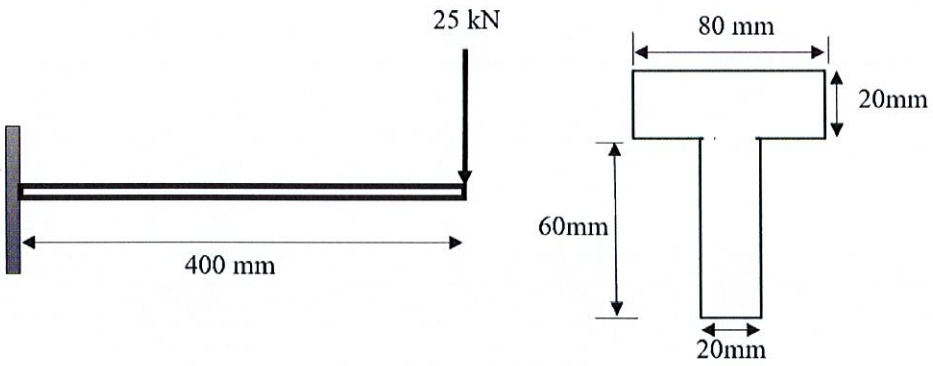



Figure 3(b) / *Rajah 3(b)*

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 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:*

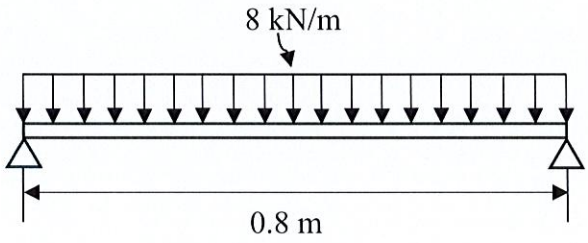



Figure 3(c) / *Rajah 3(c)*

i. The slope of the beam.
*Kecerunan rasuk.*

[5 marks]
[*5 markah*]

ii. New Young Modulus if the maximun deflection is $1.41\times10^{-4}$m.
*Modulus Young jika pesongan maksimun adalah $1.41\times10^{-4}$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

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

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

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

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

## 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**

$$P_1 = P_2$$

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

**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

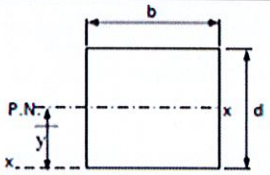
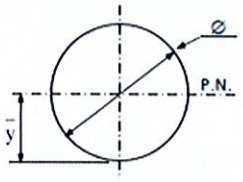
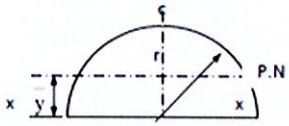
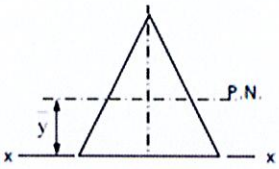
$$T = T_1 + T_2$$

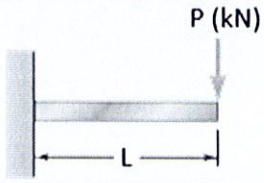
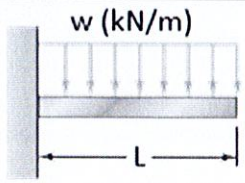
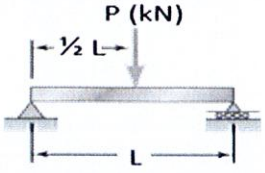
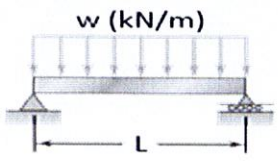
$$\theta_1 = \theta_2$$

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

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