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 : 2026/2027

DJJ30323: STRENGTH OF MATERIALS

TARIKH : 21 OKTOBER 2026
MASA : 11.30 PAGI – 1.30 PETANG (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)

TERBUKA

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) Define the following in engineering term.

i. Stress

ii. Young's Modulus

Definasi istilah berikut dalam terma kejuruteraan.

i. Tegasan

ii. Modulus Young

[4 marks]

[4 *markah*]

CLO1 (b) An alloy wire of 2 mm^2 cross-sectional area and 12 N force hangs freely. Find the maximum length of the wire, if its extension is not to exceed 0.6 mm. Take Young's Modulus of the wire material as 150 GN/m^2.

Wayar aloi dengan luas keratan rentas 2 mm^2 dan daya 12 N tergantung bebas. Cari panjang maksimum wayar itu, jika pemanjangannya tidak melebihi 0.6mm. Ambil Modulus Young untuk bahan wayar sebagai 150 GN/m^2.

[8 marks]

[8 *markah*]

CLO1 (c) A series of steel and aluminium bars is fixed in between two rigid walls as Figure 1(c). If the temperature is lowered to 50°C, calculate:

Given: $E_{steel} = 200\ GN/m^2$; $\alpha_{Steel} = 12 \times 10^{-6}/°C$; $A_{Steel} = 100mm^2$

$E_{Al} = 69\ GN/m^2$; $\alpha_{Al} = 23 \times 10^{-6}/°C$; $A_{Al} = 200mm^2$

TERBUKA

Satu bar sesiri yang terdiri keluli dan aluminium dipasang tegar antara dua dinding seperti dalam Rajah 1(c). Jika suhu menurun kepada 50°C, kirakan:

Diberikan: $E_{steel} = 200\ GN/m^2$; $\alpha_{Steel} = 12 \times 10^{-6}\ /°C$; $A_{Steel} = 100mm^2$

$E_{Al} = 69\ GN/m^2$; $\alpha_{Al} = 23 \times 10^{-6}\ /°C$; $A_{Al} = 200mm^2$

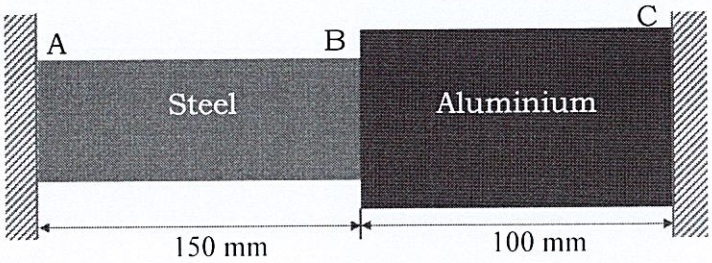

Figure 1 (c)/ *Rajah 1 (c)*

i. Diameter for both material composite bar

Diameter bagi kedua-dua bahan bar komposit

[2 marks]

[*2 markah*]

ii. Thermal stress in each bar

Tegasan suhu dalam setiap bar

[11 marks]

[*11 markah*]

TERBUKA

QUESTION 2

SOALAN 2

CLO1 (a) Explain simply supported beam and overhanging beam based on their definitions and give an example for each type.

Jelaskan rasuk disokong mudah dan rasuk tergantung berdasarkan definasi dan contoh bagi setiap jenis tersebut.

[6 marks]

[*6 markah*]

CLO1 (b) An overhanging beam ABC is supported at points A and B as shown in Figure 2 (b). It carries a uniformly distributed load of 7 kN/m along 6m and a concentrated load 16 kN at point C. Calculate:

Satu rasuk tergantung ABC disokong pada titik A dan B seperti Rajah 2(b) dibawah. Ia membawa beban teragih seragam 7 kN/m di sepanjang 6m dan beban tumpu 16 kN pada titik C. Kirakan:

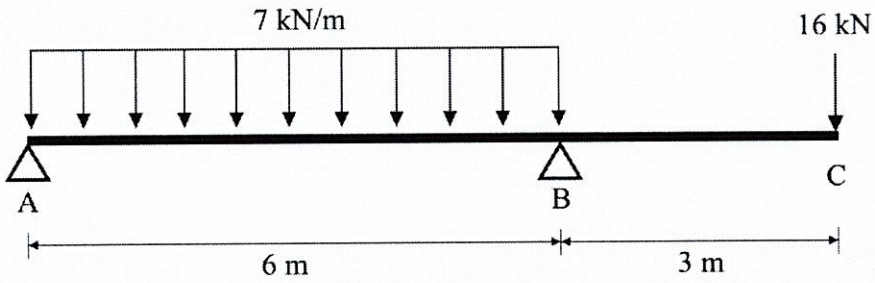

Figure 2(b) / *Rajah 2(b)*

i) The reaction forces at support A and B

Daya tindakbalas pada penyokong A and B

[4 marks]

[4 *markah*]

ii) The value of shear force along the beam

Nilai daya ricih disepanjang rasuk

[4 marks]

[4 *markah*]

TERBUKA

CLO1 (c) Referring to the value of reaction force in Question 2b (i),
Merujuk kepada nilai daya tindakbalas dalam Soalan 2b (i),

i) Calculate the bending moment along the beam
Kirakan momen lentur disepanjang rasuk

[3 marks]
[3 *markah*]

ii) Sketch the shear force and bending moment diagrams.
Lakarkan gambarajah daya ricih dan momen lentur.

[8 marks]
[8 *markah*]

TERBUKA

QUESTION 3

SOALAN 3

CLO2 (a) Based on the equation below, state the meaning of each symbol and its correct SI unit for the symbols given.

Berdasarkan persamaan di bawah, nyatakan maksud setiap simbol dan unit SI yang betul bagi simbol yang diberikan.

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

[5 marks]

[*5 markah*]

CLO2 (b) A steel cantilever beam 6 m in length is subjected to a concentrated load of 1200 N acting at the free end of the beam. The beam is of rectangular cross section, 4 cm wide and 6 cm deep as shown in Figure 3(b).

Sebatang rasuk julur keluli yang mempunyai panjang 6 m dikenakan beban tumpu sebanyak 1200 N yang bertindak pada hujung bebas rasuk tersebut. Rasuk itu mempunyai keratan rentas segi empat tepat dengan lebar 4 cm dan kedalaman 6 cm seperti Rajah 3 (b).

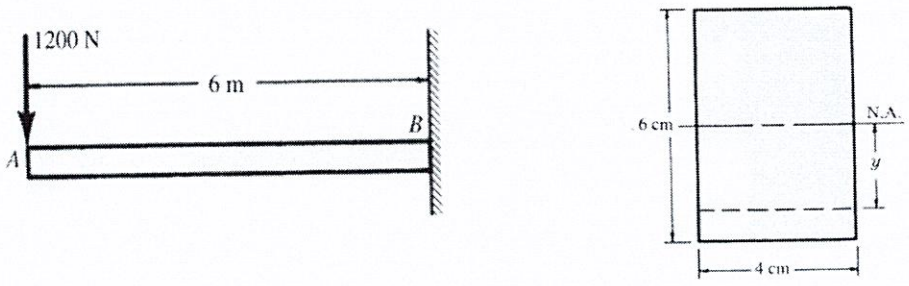

Figure 3(b) / *Rajah 3(b)*

i) Calculate the maximum bending stresses in the beam. Neglect the weight of the beam.

Kirakan tegasan lenturan maksimum rasuk. Abaikan berat rasuk.

[5 marks]

[5 *markah*]

TERBUKA

ii) Referring to Question 3(b) if rectangular beam is replaced by a beam with cross section shown in Figure 3(b)(ii). Determine the maximum bending stresses.

Merujuk kepada Soalan 3(b), bagi keadaan di mana rasuk berkeratan rentas segi empat tepat digantikan dengan rasuk yang mempunyai keratan rentas seperti yang ditunjukkan dalam Rajah 3(b)(ii). Tentukan tegasan lenturan maksimum.

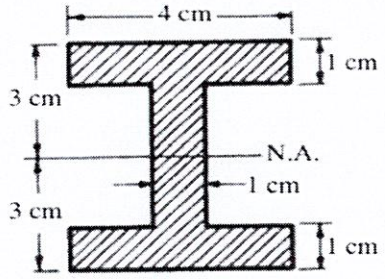

Figure 3(b)(ii) / *Rajah 3(b)(ii)*

[5 marks]

[*5 markah*]

CLO2 (c) A cantilever beam with a length of 4 m has a flexural rigidity (EI) of 20 MN/m². The beam is subjected to a concentrated load of 1 KN acting at its free end. Calculate:

Sebuah rasuk julur dengan panjang 4 m mempunyai kekakuan lenturan (EI) sebanyak 20 MN/m². Rasuk tersebut dikenakan beban tumpu sebanyak 1 KN yang bertindak pada hujung bebas rasuk. Kirakan:

i) The deflection for the beam.

Pesongan bagi rasuk

[4 marks]

[*4 markah*]

ii) slope at the free end of the beam.

Kecerunan di hujung rasuk

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[4 marks]

[*4 markah*]

iii) If the permissible deflection limit is 2.0 mm, determine the adequacy of the beam design.

Sekiranya had pesongan maksimum dibenarkan ialah 2.0 mm, tentukan sama ada reka bentuk rasuk tersebut memenuhi keperluan yang ditetapkan.

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[2 marks]

[*2 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) A compound shaft consists of two or more distinct sections or materials connected to transmit rotational power and torque. Compound shafts can be arranged in either series or parallel configurations. Compare:

Aci kompaun terdiri daripada dua atau lebih bahagian atau bahan yang berbeza yang disambungkan untuk menghantar kuasa putaran dan tork. Aci kompaun boleh disusun sama ada dalam konfigurasi siri atau selari. Bandingkan:

i) Differences between the Series Shaft and Parallel Shaft using schematic diagrams.

Perbezaan antara aci sesiri dan aci selari menggunakan gambarajah skematik.

[2 marks]

[*2 markah*]

ii) The equations related to torque and angle of twist for both shafts.

Formula yang berkaitan dengan tork dan sudut kilasan kedua-dua aci

[4 marks]

[*4 markah*]

CLO2 (b) A series compound shaft consists of two solid circular shafts connected to transmit torque. Shaft AB is made from brass, with a diameter of 36 mm, a length of 400 mm and modulus rigidity is 39 GPa. Shaft BC is made from aluminium with a diameter of 60 mm, a length of 625 mm and modulus rigidity is 26 GPa. If the torque of 200 Nm imposes at end of BC, calculate:

Satu aci kompaun bersiri terdiri daripada dua aci bulat padu disambungkan untuk menghantar tork. Aci AB diperbuat daripada loyang dengan diameter of 36 mm, panjang 400 mm and modulus ketegaran adalah 39 GPa. Aci BC diperbuat daripada aluminium dengan diameter 60 mm, panjang 625 mm dan

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modulus ketegaran 26GPa. Jika tork 200 Nm dikenakan pada hujung BC, kirakan:

i. The second polar moment of area shaft, J.
Momen luas kutub kedua bagi setiap aci, J.

[4 marks]
[*4 markah*]

ii. The total angle of twist developed by the compound shaft.
Jumlah sudut kilasan yang dihasilkan oleh aci gabungan.

[7 marks]
[*7 markah*]

CLO2 (c) A solid steel shaft in a rolling mill transmits 20 kW of power at 120 rpm. The shear stress must not exceed 40 MPa and the angle of twist is limited to 6° in a length of 3 m. Use G = 83 GPa. Calculate:
Aci keluli padu di dalam sebuah kilang besi menghantar 20 kW kuasa pada 120 rpm. Tegasan ricih tidak boleh melebihi 40 MPa dan sudut putaran adalah terhad kepada 6° pada panjang 3 m. Gunakan G = 83 GPa. Kirakan:

i) The torque transmitted by the shaft
Tork yang dihantar oleh aci

[2 marks]
[*2 markah*]

ii) The diameter of the shaft based on the allowable shear stress.
Diameter aci berdasarkan tegasan ricih yang dibenarkan.

[3 marks]
[*3 markah*]

iii) The diameter of the shaft based on the allowable angle of twist.
Diameter aci berdasarkan sudut putaran yang dibenarkan.

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[3 marks]
[*3 markah*]

SOALAN TAMAT

POLITEKNIK MALAYSIA

DJJ30323 : 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

$$T = T_1 + T_2$$

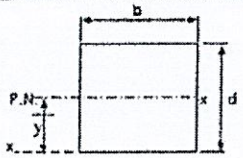
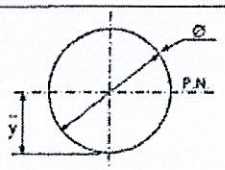
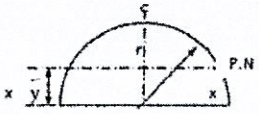
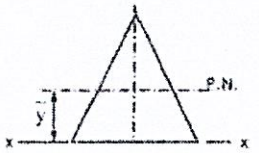
$$\theta_1 = \theta_2$$

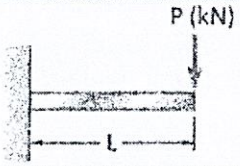
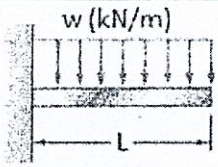
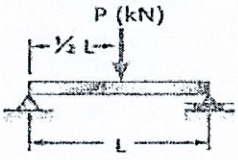
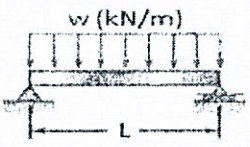
$$\frac{T_1 L_1}{G_1 J_1} = \frac{T_2 L_2}{G_2 J_2}$$

TERBUKA

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

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