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 : 2023/2024

DJJ30103: STRENGTH OF MATERIALS

TARIKH : 22 DISEMBER 2023
MASA : 8.30 AM – 10.30 AM (2 JAM)

Kertas ini mengandungi **LAPAN (8)** 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 berstuktur. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1

(a) Explain the terms below with units:

Terangkan istilah-istilah di bawah beserta unit:

i. *Stress*

Tegasan

[2 marks]

[2 *markah*]

ii. Strain

Keterikan

[2 marks]

[2 *markah*]

iii. Young Modulus

Modulus Young

[2 marks]

[2 *markah*]

iv. Safety Factor

Faktor Keselamatan

[2 marks]

[2 *markah*]

v. Poisson Ratio

Nisbah Poisson

[2 marks]

[2 *markah*]

CLO 1

(b) A steel tube, 25mm outside diameter and 12mm inside diameter, carries an axial tensile load of 40kN, Calculate:

Sebatang tiub besi yang mempunyai diameter luar 25mm dan diameter dalam 12mm membawa beban sepaksi tegangan sebanyak 40kN.

i. Stress in the tube.

Kirakan tegasan tiub tersebut.

[4 marks]

[4 *markah*]

ii. The value of Safety Factor, if the maximum stress in the tube is limited to 325 MN/m^2.

Sekiranya tegasan maximum adalah 325MN/m^2, kira nilai Faktor Keselamatan.

[3 marks]

[3 *markah*]

CLO1

(c) A concrete pillar, which is reinforced with steel rods, supports a compressive axial load of 2MN. Given that $A_1 = 4mm^2$ and E_1=200GPa and A_2=0.2m^2 and E_2=20GPa.

Konkrit pillar yang diperkuatkan dengan rod besi, menyokong daya mampatan sebanyak 2MN. Diberi $A_1 = 4mm^2$ dan E_1=200GPa dan A_2=0.2m^2 dan E_2=20GPa.

i. Write **TWO (2)** equations involved.

*Tuliskan **DUA (2)** persamaan yang terlibat.*

[3 marks]

[3 *markah*]

ii. Calculate the stress in steel rod and concrete pillar.

Kirakan tegasan di dalam rod keluli dan tiang konkrit.

[5 marks]

[5 *markah*]

QUESTION 2
SOALAN 2

An overhanging beam is subjected with load as shown in Figure 2 below,
Sebatang rasuk tergantung dikenakan dengan beban seperti yang ditunjukkan dalam Rajah 2 di bawah,

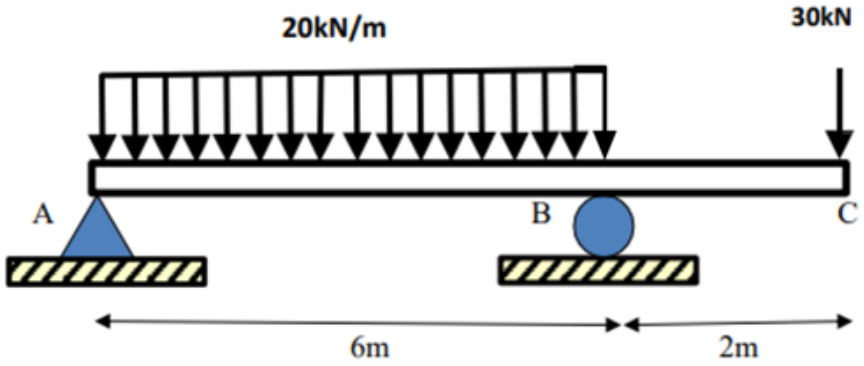


Figure 2/Rajah 2

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

[5 marks]
[*5 markah*]

CLO 1 (b) Based on reaction force value:
Berdasarkan nilai daya tindak balas:

i. Calculate the shear force along the beam [4 marks]
Kirakan daya ricih sepanjang rasuk [4 *markah*]

ii. Sketch the shear force diagram. [4 marks]
Lakarkan gambarajah daya ricih. [4 *markah*]

CLO 1

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

i. Calculate the bending moment value. [4 marks]
Kirakan nilai momen lentur. [4 *markah*]

ii. Sketch the bending moment diagram. [4 marks]
Lakarkan gambarajah momen lentur. [4 *markah*]

iii. Show the maximum point position in the diagram
Tunjukkan kedudukan momen lentur maksimum dalam gambarajah
[4 marks]
[4 *markah*]

QUESTION 3

SOALAN 3

CLO 2

(a) Based on the equation below, name each symbol below and its unit:
Berdasarkan persamaan dibawah, namakan setiap simbol dan unit

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

[6 marks]
[6 markah]

CLO 2

(b) A steel cantilever beam 6m in length is subjected to a concentrated load of 1200 N acting at the free end of the bar. The beam with cross section shown Figure 3(b). *Rasuk julur yang mempunyai panjang rasuk 6m dikenakan beban 1200N di hujung beam yang bebas. Keratan rentas di tunjukkan seperti Rajah 3(b)*

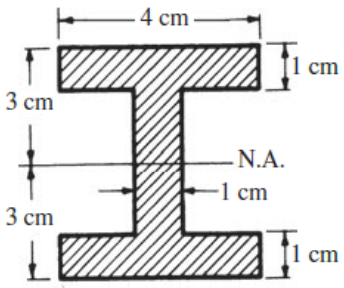


Figure 3(b)/*Rajah 3(b)*

Calculate:
Kirakan:

i) The neutral axis of the I-section. [2 marks]
Paksi neutral bagi keratan I. [*2 markah*]

ii) The second moment of area of the I-section. [4 marks]
Momen luas kedua bagi keratan I. [4 *markah*]

iii) Maximum bending stress. [3 marks]
Tegasan lentur maksimum. [*3 markah*]

CLO 2

(c) A cantilever beam is 4m long with a flexural stiffness (EI) of 20MNm^2. It has a point load of 1kN at the free end and uniformly distributed load of 300N/m along its entire length. Determine:
Rasuk julur berukuran 4m panjang dengan nilai kekakuan lenturan(EI) 20MNm^2. Ia dikenakan beban tumpu 1kN di hujung rasuk dan beban teragih seragam sebanyak 300N/m disepanjang rasuk. Tentukan:

i. Deflection of the beam. [5 marks]
Pesongan rasuk. [*5 markah*]

ii. Slope at the free end of the beam. [5 marks]
Kecerunan di hujung bebas rasuk. [*5 markah*]

QUESTION 4

SOALAN 4

CLO 2 (a) State the equation and unit for Second Polar Moment of Area for solid cylinder and hollow cylinder.

Nyatakan formula dan unit bagi polar Moment Luas Kedua bagi aci silinder padu dan aci silinder berongga.

[5 marks]

[5 markah]

CLO 2 (b) A shaft with 60mm diameter and 0.9m long is subjected to a torque of 1300Nm. Given G= 70 GPa, calculate:

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

i. Second polar moment. [3 marks]

Momen kutub kedua. [3 *markah*]

ii. Angle of twist in degree. [5 marks]

Sudut putaran bagi aci dalam unit darjah. [5 *markah*]

CLO 2

(c) Consider a composite shaft fabricated from a 6cm diameter solid aluminium alloy, G_{al} =28GPa, surrounded by a hollow steel circular shaft of outside diameter 7cm and inside diameter 6cm, with G_{st} = 84GPa. The two metals are rigidly connected. Composite shaft is loaded by a twisting moment of 154kNm. Determine

Pertimbangkan satu aci berukuran 6cm diameter diperbuat dari aluminium aloi, G= 28GPa, dikelilingi oleh keluli bergeronggang yang mempunyai diameter luar 7cm dan diameter dalam 6cm dengan G = 84GPa. Kedua-dua bahan diikat tegar. Momen kilasan adalah 154kNm. Tentukan:

i. Second Polar Moment for aluminum and hollow steel. [4 marks]
Momen kutub kedua bagi aluminium dan keluli berongga. [*4 markah*]

ii. Shearing stress in the steel. [6 marks]
Tegasan ricih bagi keluli. [*6 markah*]

iii. Shearing stress in the aluminum. [2 marks]
Tegasan ricih bagi aluminium. [2 *markah*]

SOALAN TAMAT

LIST OF FORMULA DJJ30103 - STRENGTH OF MATERIALS

FORCES ON MATERIALS

1. Safety factor = $\frac{\text{Maximum Stress}}{\text{Work Stress}}$

2. Poisson's Ratio, ν = $\frac{\text{laterial strain}}{\text{longitudinal strain}}$

3. Percent Elongation = $\frac{\text{Elongation}}{\text{Length}}$ x 100 %

4. Percent reduction in area = $\frac{A_{f-A_o}}{A_o}$ x 100 %

5. Strain Energy, U = $\frac{1}{2}$ PΔL

THERMAL STRESSES AND COMPOSITE BARS

1. Equation of a parallel composite bar subjected to a temperature change.

$$\frac{\sigma_1}{E_1} + \frac{\sigma_2}{E_2} = (\alpha_2 - \alpha_1)\,\Delta t$$

2. Equation of a series composite bar subjected to a temperature change.

$$\frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 E_2} = \Delta t(\alpha_1 L_1 + \alpha_2 L_2)$$

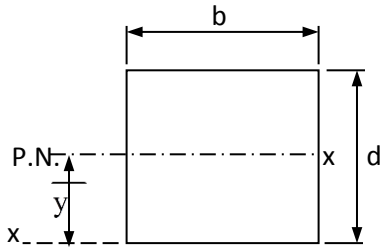
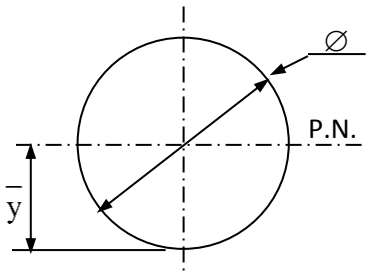
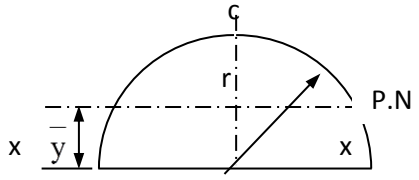
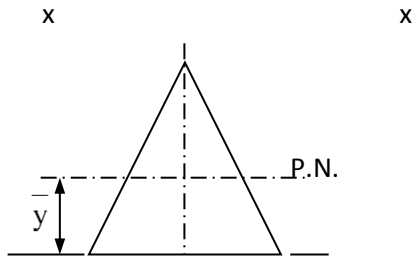
SHEAR FORCES AND BENDING MOMENT

$\sum M_A$ (↻) = $\sum M_A$ (↺)

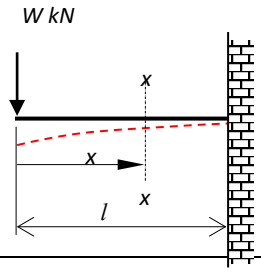
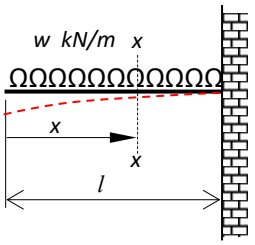
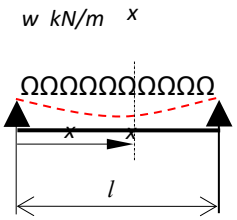
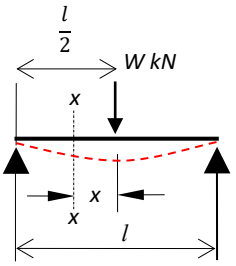
$\sum F \uparrow$ = $\sum F \downarrow$

BENDING STRESS

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

SHAPE	CENTROID	MOMENT OF INERTIA
	$\bar{x} = b/2$ $\bar{y} = d/2$	$I_{P.N.} = \frac{bd^3}{12}$ $I_{xx} = \frac{bd^3}{3}$
	$\bar{x} = d/2$ $\bar{y} = d/2$	$I_{P.N.} = \frac{\pi d^4}{64} = \frac{\pi r^4}{4}$
	$\bar{y} = \frac{4r}{3\pi}$	$I_{P.N} = 0.11 r^4$ $I_{xx} = \frac{\pi r^4}{8}$
	$\bar{y} = h/3$	$I_{P.N.} = \frac{bh^3}{36}$ $I_{xx} = \frac{bh^3}{12}$ $I_{yy} = \frac{hb^3}{48}$

BEAM DEFLECTION

Case	(Θ_{max}= dy/dx)	(y_{max})
	$\frac{Wl^2}{2EI}$	$-\frac{Wl^3}{3EI}$
	$\frac{wl^3}{6EI}$	$-\frac{wl^4}{8EI}$
	$\pm\frac{wl^3}{24EI}$	$-\frac{5wl^4}{384EI}$
	$\pm\frac{Wl^2}{16EI}$	$-\frac{Wl^3}{48EI}$

TORSION OF SHAFT

1. TORSION FORMULA

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

2. POLAR MOMENT OF INERTIA

$$J=\frac{\pi d^4}{32}$$

3. SERIES COMPOSITE SHAFT

$$T=\frac{G_1\theta\, J_1}{L_1}=\frac{G_2\theta_2 J_2}{L_2}$$

$$\begin{aligned}\theta_{AC} &= \theta_{AB}+\theta_{BC}\\ &= \frac{T_1L_1}{G_1J_1}+\frac{T_2L_2}{G_2J_2}\\ &= T\left(\frac{L_1}{G_1J_1}+\frac{L_2}{G_2J_2}\right)\end{aligned}$$

4. PARALLEL COMPOSITE SHAFT

$$T = T_1 + T_2$$

$$\theta=\left(\frac{T_1L_1}{G_1J_1}\right)=\left(\frac{T_2L_2}{G_2J_2}\right)$$