

**SULIT**



**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK  
KEMENTERIAN PENDIDIKAN TINGGI**

**JABATAN KEJURUTERAAN MEKANIKAL**

**PEPERIKSAAN AKHIR  
SESI DISEMBER 2016**

**DJJ3103: STRENGTH OF MATERIALS**

**TARIKH : 07 APRIL 2017  
MASA : 8.30 AM – 10.30 AM (2 JAM)**

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**Kertas ini mengandungi TUJUH (7) halaman bercetak.**

**( Struktur : 4 Soalan )**

**Dokumen sokongan yang disertakan: Rumus**

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

**(CLO yang tertera hanya sebagai rujukan)**

**SULIT**

**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**

- CLO 1  
C1
- a) State **FIVE (5)** types of loads on the material.  
*Nyatakan LIMA (5) jenis daya ke atas bahan.*
- [5 marks]  
[5 markah]
- CLO 1  
C2
- b) An  $1130 \text{ mm}^2$  cross sectional area of 50 mm long steel bar is subjected to a tensile force of 20 kN and cause the elongation of 0.0435 mm. Determine:  
*Sebatang bar keluli mempunyai luas keratan rentas  $1130 \text{ mm}^2$  dengan 50 mm panjang dikenakan daya tegangan 20 kN menyebabkan pemanjangan sebanyak 0.0435 mm. Tentukan :*
- i. The stress in the bar  
*Tegasan dalam bar*
- [3 marks]  
[3 markah]
- ii. Normal strain  
*Terikan normal*
- [2 marks]  
[2 markah]
- iii. Young's Modulus  
*Modulus Keanjalan*
- [2 marks]  
[2 markah]

- CLO 1  
C4
- c) A series composite bar consist of  $900 \text{ mm}^2$  cooper rod and  $600 \text{ mm}^2$  steel rod bounded rigidly with initial temperature of  $10^\circ\text{C}$ . Calculate the stress in each rod when temperature raised to  $22^\circ\text{C}$ . If the stress in steel rod is increased by 35%, determine the new stresses in each bar and the new temperature change. Analyze the relationship between stress and temperature change. Assuming each rod is 1m length.
- Satu siri bar majmuk terdiri daripada  $900\text{mm}^2$  rod kuprum dan  $600\text{mm}^2$  rod keluli diikat secara tegar dengan suhu awal  $10^\circ\text{C}$ . Kirakan tegasan pada setiap rod apabila suhu meningkat kepada  $22^\circ\text{C}$ . Jika tegasan dalam rod keluli meningkat sebanyak 35% tentukan, tegasan baru pada setiap rod dan perubahan suhu yang baru. Analisis hubungkait diantara tegasan dan perubahan suhu. Anggapan setiap rod adalah 1m panjang.*

$$E_{\text{steel}} = 200\text{GPa} \quad \alpha_{\text{steel}} = 12 \times 10^{-6} / ^\circ\text{C}$$

$$E_{\text{keluli}} = 200\text{GPa} \quad \alpha_{\text{keluli}} = 12 \times 10^{-6} / ^\circ\text{C}$$

$$E_{\text{cooper}} = 100\text{GPa} \quad \alpha_{\text{cooper}} = 17 \times 10^{-6} / ^\circ\text{C}$$

$$E_{\text{kuprum}} = 100\text{GPa} \quad \alpha_{\text{kuprum}} = 17 \times 10^{-6} / ^\circ\text{C}$$

[ 13 marks]

[13 markah]

## QUESTION 2

## SOALAN 2

A simple supported beam is loaded as shown in Figure 2

*Satu rasuk mudah dikenakan beban seperti Rajah 2*

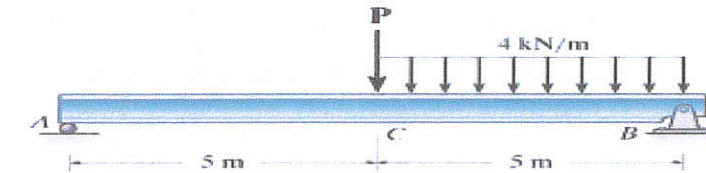


Figure 2.1/ Rajah 2

- CLO1  
C2
- a) Sketch a free body diagram for beam as in Figure 2 and calculate the reaction force if  $P=20\text{kN}$
- Lakarkan gambarajah badan bebas bagi rasuk seperti Rajah 2 dan kirakan daya tindak balas, sekiranya  $P=20\text{kN}$*
- [5 marks]  
[5markah]
- CLO1  
C3
- b) Calculate shear force and bending moment
- kirakan daya ricih dan momen lentur*
- [12 marks]  
[12 markah]
- CLO1  
C4
- c) Analyze the bending moment maximum and its position from the left of the beam based on shear force and bending moment diagram
- Analisa momen lentur maksima dan kedudukannya dari kiri rasuk berdasarkan gambarajah daya ricih dan momen lentur.*
- [8 marks]  
[8 markah]

QUESTION 3

SOALAN 3

CLO1  
C1

- a. Name each parameters below with their unit.

*Namakan setiap pembolehubah dibawah berserta unit.*

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

[5 marks]

[5 markah]

CLO1  
C2

- b. Determine the neutral axis and the second moment of area of the beam with a cross section as shown in Figure 3b.

*Tentukan nilai paksi neutral dan momen luas kedua bagi rasuk yang mempunyai keratan rentas seperti Rajah 3b)*

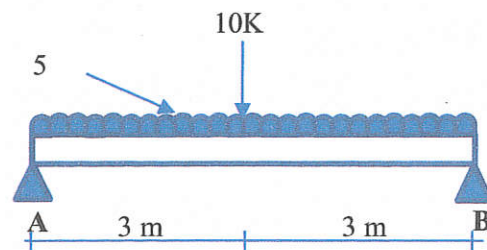


Figure 3a  
Rajah 3a

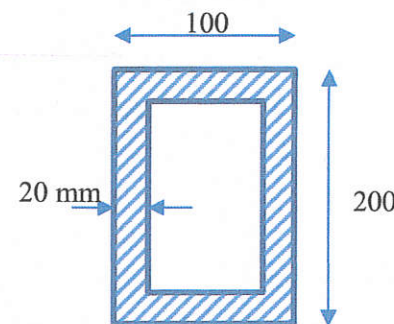


Figure 3b  
Rajah 3b

[6 marks]

[6 markah]

CLO1  
C3

- c. Based on figure 3a, determine the equation of the elastic curve of the beam and Calculate the slope at the end of point B.

*Berdasarkan rajah 3a, tentukan persamaan lengkung elastic dan kirakan kecerunan pada titik B.*

[14 marks]

[14 markah]

QUESTION 4

SOALAN 4

A solid circular shaft of a series of compound made from steel is shown in figure 4. Length AB and BC are 400mm and 200 mm, diameter AB and BC are 50 mm and 30mm. If torque of 200Nm imposed at end of BC. Given  $G = 70GN/m^2$ .

*Sebatang aci bulat padu siri dibuat daripada keluli seperti ditunjukkan dalam rajah 4(a).*

*Panjang AB dan BC adalah 400mm and 200 mm, diameter AB dan BC adalah 50 mm and 30mm. Jika tork 200Nm dikenakan pada hujung BC. Diberi  $G = 70GN/m^2$*

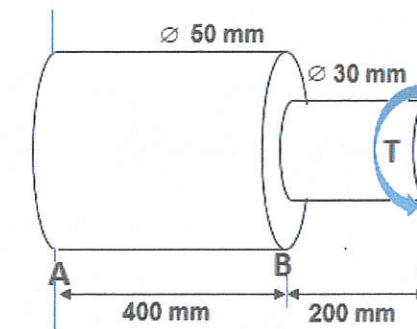


Figure 4/Rajah 4

CLO1  
C1

- a) Define torque and give **THREE** (3) torque's application in engineering.

*Takrifkan dayakilas dan berikan TIGA (3) aplikasi daya kilas dalam kejuruteraan*

[5 marks]

[5 markah]

CLO1  
C2

- b) Calculate the angle of twist.

*Kirakan sudut pihan.*

[8 marks]

[8 markah]

CLO1  
C3

- c) A solid steel shaft 5 m long is stressed at 80 MPa when twisted through 4°.

Using  $G = 83 \text{ GPa}$ , calculate:

*Sebuah aci keluli padu dengan 5m panjang dikenakan tegasan 80MPa apabila dipiuh pada 4°.*

*Menggunakan  $G = 83 \text{ GPa}$ , kirakan:*

- i) The shaft diameter.

*Diameter aci*

[8 marks]

[8 markah]

- ii) Power transmitted by the shaft at 20 rev/min.

*Kuasa yang dihantar oleh aci pada 20 ppm*

[4 marks]

[4 markah]

SOALAN TAMAT

### LIST OF FORMULA DJJ3103 - STRENGTH OF MATERIALS

#### FORCES ON MATERIALS

1. Safety factor =  $\frac{\text{Maximum Stress}}{\text{Work Stress}}$
2. Poisson's Ratio,  $\nu = \frac{\text{lateral strain}}{\text{Normal strain}}$
3. Percent Elongation =  $\frac{\text{Elongation}}{\text{Original Length}} \times 100 \%$
4. Percent reduction in area =  $\frac{A_f - A_o}{A_o} \times 100 \%$
5. Strain Energy,  $U = \frac{1}{2} P \Delta L$

#### 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.

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

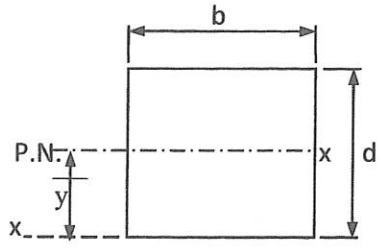
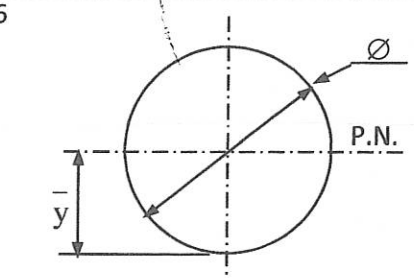
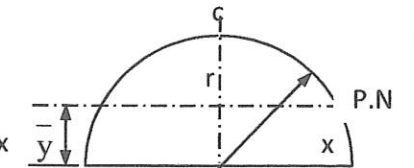
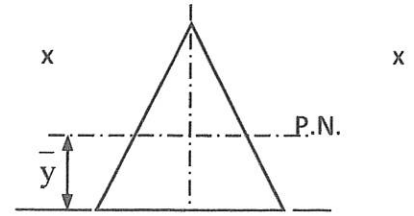
#### SHEAR FORCES AND BENDING MOMENT

$$\sum M_A = \sum M_A$$

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

### BENDING STRESS

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

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

### 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

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

$$\begin{aligned} \theta_{AC} &= \theta_{AB} + \theta_{BC} \\ &= \frac{T_1 L_1}{G_1 J_1} + \frac{T_2 L_2}{G_2 J_2} \\ &= T \left( \frac{L_1}{G_1 J_1} + \frac{L_2}{G_2 J_2} \right) \end{aligned}$$

#### 4. PARALLEL COMPOSITE SHAFT

$$T = T_1 + T_2$$

$$\theta = \left( \frac{T_1 L_1}{G_1 J_1} \right) = \left( \frac{T_2 L_2}{G_2 J_2} \right)$$