

**SULIT**



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

**JABATAN KEJURUTERAAN MEKANIKAL**

**PEPERIKSAAN AKHIR**

**SESI JUN 2017**

**DJJ3103 : STRENGTH OF MATERIAL**

**TARIKH : 27 OKTOBER 2017**

**MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)**

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Kertas ini mengandungi LAPAN (8) halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Rumus dan Jadual Stim

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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 struktur. Jawab semua soalan.*

**QUESTION 1****SOALAN 1**

- CLO 1 a) Define the terms below:  
C1 *Nyatakan definisi bagi istilah berikut:*
- i. Stress and Strain  
*Tegasan dan Keterikan*
- [2 marks]  
[2 markah]
- ii. Hooke's Law  
*Hukum Hooke's*
- [1 marks]  
[1 markah]
- ii. Young's Modulus  
*Modulus Keanjalan*
- [2 marks]  
[2 markah]
- CLO 1 b) A 12 mm diameter and 50 mm long bar is subjected to a tensile force of 20 kN. The  
C2 elongation of bar is 0.0435 mm and the diameter of bar is change to 11.996 mm. Determine :  
*Sebatang bar berukuran 12 mm diameter dan 50 mm panjang dikenakan daya tegangan 20 kN. Bar tersebut mengalami pemanjangan sebanyak 0.0435 mm dan diameter berubah kepada 11.996 mm. Tentukan :*

- i. The stress in the bar

*Tegasan dalam bar*

[2 marks]

[2 markah]

- ii. Tensile strain

*Keterikan yang berlaku*

[2 marks]

[2 markah]

- iii. Lateral strain

*Keterikan sisi*

[2 marks]

[2 markah]

- iv. Young's Modulus

*Modulus Keanjalan*

[1 marks]

[1 markah]

CLO 1  
C4

- c) A compound bar consisting 1 m long copper rod with a diameter of 50 mm mounted into a steel tube of 50 mm internal diameter and 60 mm outer diameter is applied onto a load of 150 kN. Calculate:

*Sebatang bar majmuk panjangnya 1m terdiri daripada rod tembaga berdiameter 50 mm yang dipasang ke dalam satu tiub keluli berdiameter dalam 50 mm dan luar 60 mm**dikenakan beban sebanyak 150 kN. Kirakan:*

Given :  $E_s = 200 \text{ GN/m}^2$ ,  $E_c = 100 \text{ GN/m}^2$

- i. Stress in the steel tube and copper rod.

*Tegasan dalam tiub keluli dan rod tembaga.*

[13 marks]

[13 markah]

QUESTION 2  
SOALAN 2

A simply supported beam carrying a few loads as shown on Figure 2 below.

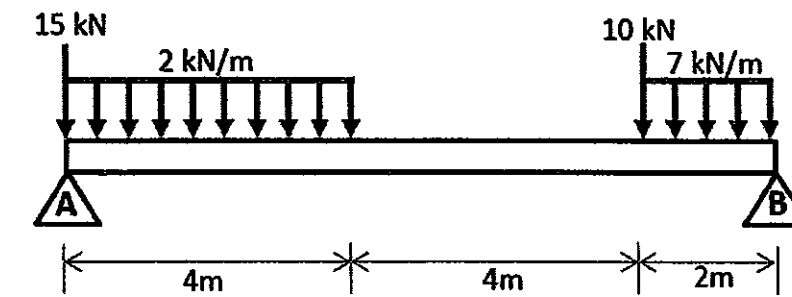
*Rasuk disangga mudah membawa beberapa beban seperti di bawah seperti Rajah 2 dibawah.*

Figure 2 / Rajah 2

CLO 1  
C2

- a) Calculate the reaction force for beam in Figure 2 and sketch the free body diagram.

*Kirakan daya tindakbalas untuk Rajah 2 dan lakarkan gambarajah badan bebas*

[5 marks]

[5 markah]

CLO 1  
C3

- b) Calculate the shear force and bending moment for the beam.

*Kirakan daya ricih dan momen lentur bagi rasuk.*

[12 marks]

[12 markah]

CLO 1  
C4

- c) Draw the shear force and bending moment diagram for the beam and determine the maximum bending moment and its position.

*Lukiskan gambarajah daya ricih dan momen lentur bagi rasuk dan tentukan nilai momen letur maksimum dan posisinya.*

[8 marks]

[8 markah]

## QUESTION 3

## SOALAN 3

CLO1  
C1

- (a) State FIVE (5) terms and their units for the bending stress equation below;  
Nyatakan LIMA (5) terma beserta unitnya bagi persamaan tegasan lentur di bawah;

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

[5 marks]  
[5 markah]

CLO1  
C2

- (b) A simply supported beam with a cross-section is shown in Figure 3(b) below. Determine the value of Neutral Axis and Second Moment Area of the beam.  
Satu rasuk disangga mudah dengan keratan rentas seperti yang ditunjukkan dalam Rajah 3(b). Tentukan nilai Paksi Neutral dan Momen Luas Kedua rasuk tersebut.

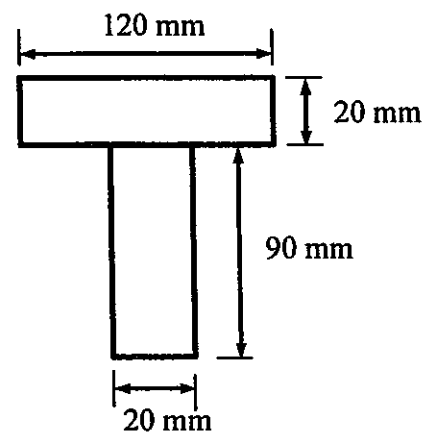


Figure 3(b) / Rajah 3(b)

[6 marks]  
[6 markah]

CLO1  
C3

- (c) A simply supported beam shown in Figure 3(c) is loaded with uniformly distributed load. Given the  $EI = 2.5 \times 10^6 \text{ Nm}^2$ . By using the double integration method, calculate;

Satu rasuk disangga mudah seperti dalam Rajah 3(c) dikenakan beban teragih seragam. Diberi nilai,  $EI = 2.5 \times 10^6 \text{ Nm}^2$ . Dengan menggunakan kaedah kamiran berganda, kirakan;

- i) The maximum slope / Kecerunan maksimum  
ii) The maximum deflection / Pesongan maksimum

[ 11 marks ]  
[ 11 markah ]

[ 3 marks ]  
[ 3 marks ]

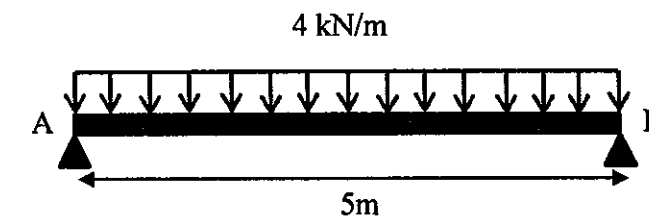


Figure 3(c) / Rajah 3(c)

**QUESTION 4**  
**SOALAN 4**

(a) State the meaning of each symbol and its units for equations below.

*Nyatakan maksud setiap simbol berikut dan unitnya untuk persamaan dibawah.*

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

[5 marks]  
[5 markah]

(b) Figure 4a displays copper rods with diameter of 50 mm and length of 0.5 m that are connected in series with a steel pipe of 50 mm outer diameter and 0.3 m of long. The steel pipe carries the torsion load of 250 Nm. If the angle of twist for steel pipes is twice the angle of twist of copper rod, calculate:

Given:  $G_{\text{Steel}} = 82 \text{ GN/m}^2$   $G_{\text{Copper}} = 40 \text{ GN/m}^2$

*Rajah 4a menunjukkan rod kuprum dengan diameter 50 mm dan panjang 0.5 m disambung secara siri bersama paip keluli juga berdiameter 50 mm dengan panjang 0.3 m. Satu daya kilas bernilai 250 Nm bertindak pada hujung paip keluli. Jika sudut kilasan paip keluli adalah dua kali ganda sudut kilasan rod kuprum, kirakan ;*

*Diberi  $G_{\text{Steel}} = 82 \text{ GN/m}^2$   $G_{\text{Copper}} = 40 \text{ GN/m}^2$*

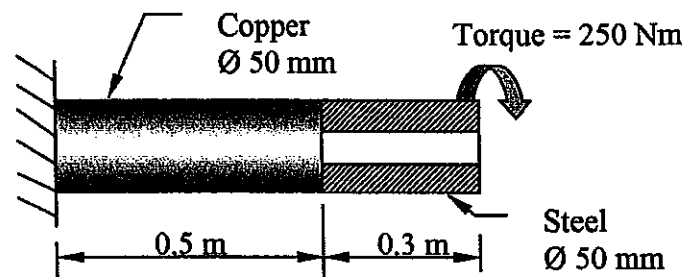


Figure 4a  
Rajah 4a

CLO1  
C2

i) The inner diameter of the steel pipe.

*Diameter dalam bagi paip keluli.*

[8 marks]

[8 markah]

CLO1  
C3

ii) The maximum allowable shear stress of the compound bar and total angle of twist.

*Tegasan ricih maksimum dibenar bagi bar siri tersebut dan jumlah sudut kilasan yang terhasil.*

[12 marks]

[12 markah]

SOALAN TAMAT

**LIST OF FORMULA JJ310- STRENGTH OF MATERIALS**

**FORCES ON MATERIALS**

1. Safety factor =  $\frac{\text{Maximum Stress}}{\text{Work Stress}}$
2. Poisson's Ratio,  $\nu = \frac{\text{lateral strain}}{\text{longitudinal strain}}$
3. Percent Elongation =  $\frac{\text{Elongation}}{\text{Length}} \times 100\%$
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**

$$\sum M_A \curvearrowright = \sum M_A \curvearrowleft$$

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

**BENDING STRESS**

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

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

## 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

$$T = T_1 + T_2$$

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