CONFIDENTIAL
94920553

UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE	:	SCB 23103 (V2)
COURSE TITLE	:	STRENGTH OF MATERIALS
PROGRAMME NAME	:	BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN MECHANICAL DESIGN
DATE	:	03 FEBRUARY 2026
TIME	:	9:00AM - 12:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☑ *Tick if applicable*

THERE ARE 8 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

The 60 kg flowerpot shown in the figure below is suspended from two wires, *AB* and *BC*. Wire *AB* makes an angle of 60° with the horizontal, and wire *BC* makes an angle of 45° with the horizontal. The diameters of the wires are 1.75 mm for wire *AB* and 1.50 mm for wire *BC*. Both wires are made of the same material and have a failure normal stress of σ_{fail} = 380 MPa. Using the information provided:

Refer Below - Figure1 : Flowerpot.

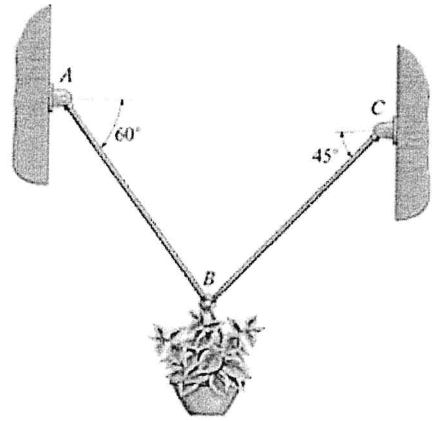


Figure 1: Flowerpot

(a) Draw a complete free-body diagram (FBD) of point *B*, showing all forces acting on the flowerpot and the tensions in wires *AB* and *BC*.

(2 marks)

(b) Write the equilibrium equations and solve the tension in wire *AB* (T_{AB}) and the tension in wire *BC* (T_{BC}).

(8 marks)

(c) Determine the normal stress σ in each wire.

(6 marks)

(d) Compute the factor of safety (F.O.S) for each wire.

(4 marks)

Question 2

The rigid bar *BDE* is supported by two vertical links *AB* and *CD*. Link *AB* is made of aluminum (Young's modulus E_{Al} = 70 GPa) with cross-sectional area A_{AB} = 500 mm². Link CD is steel (Young's modulus E_{st} = 200 GPa) with cross-sectional area A_{CD} = 600 mm². A vertical upward load of 30 kN is applied at point *E*. For the loading shown,

Refer Below - Figure2 : The rigid bar BDE .

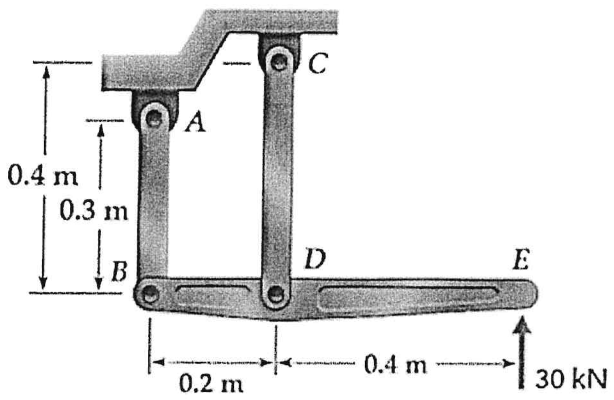


Figure 2: The rigid bar BDE

(a) Draw a free-body diagram of the bar and the two links.

(2 marks)

(b) Determine the vertical reaction forces in links AB and CD.

(6 marks)

(c) Calculate the axial deformations (vertical displacements) of points *B*, *D* and *E* due to the applied load

(12 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

The figure below shows a cantilever beam with a length L = 5 m subjected to a concentrated load P = 8.5 kN at the free end. The beam has a rectangular cross-section with a width of 60 mm and a height of 250 mm.

Refer Below - Figure3 : Cantilever beam .

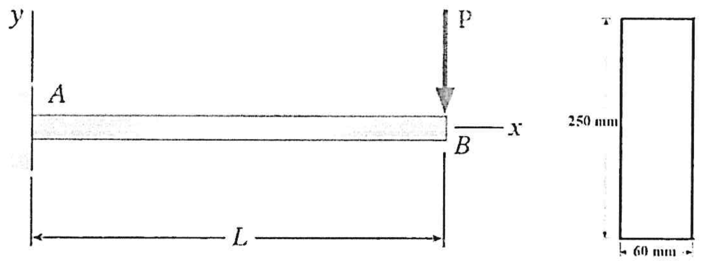


Figure 3: Cantilever beam

(a) Draw the free body diagram and find the reaction forces at the fixed support.

(6 marks)

(b) Draw the shear force diagram (SFD) and the bending moment diagram (BMD), and find the value and location of the maximum bending moment.

(8 marks)

(c) Calculate the maximum bending stress in the beam.

(6 marks)

Question 2

Figure below shows a simply supported beam *AB* subjected to a concentrated load *P* = 15 kN acting downward at point *C*. The beam is supported by a pin support at A and a roller support at *B*. The beam has a *T* cross-section as shown at the right corner with dimension.
Refer Below - Figure4 : A simply supported beam AB .

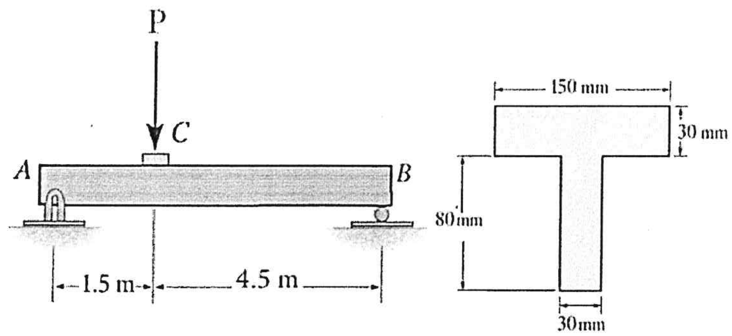


Figure 4: A simply supported beam AB

(a) Draw the free-body diagram and determine the reaction forces at the fixed support.

(5 marks)

(b) Draw the shear force diagram (SFD) and the bending moment diagram (BMD), and determine the value and location of the maximum bending moment.

(10 marks)

(c) Calculate the maximum bending stress in the beam.

(5 marks)

Question 3

The A992 steel shaft, with a uniform diameter of 50 mm, has splined ends and attached gears subjected to the torques illustrated in the figure below. The material's shear modulus, G is 75 GPa.

Refer Below - Figure5 : The A992 steel shaft .

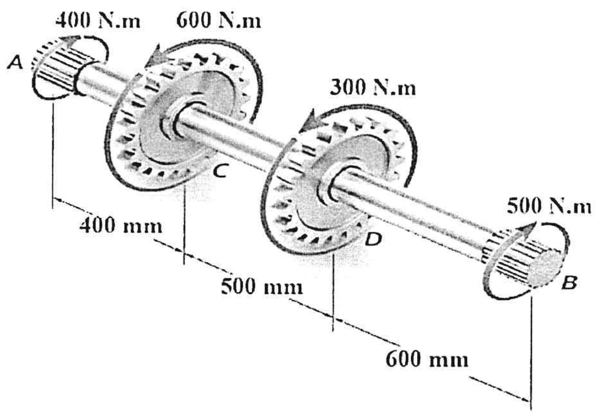


Figure 5: The A992 steel shaft

(a) Draw the torque diagram.

(6 marks)

(b) Calculate the maximum shear stress.

(6 marks)

(c) Determine the angle of twist at end B with respect to end A.

(8 marks)

Question 4

A material element is subjected to a plane state of stress, as shown in the figure below. The normal and shear stresses acting on the element are specified. Using Mohr's Circle method, answer the following:

Refer Below - Figure6 : Plane State of Stress .

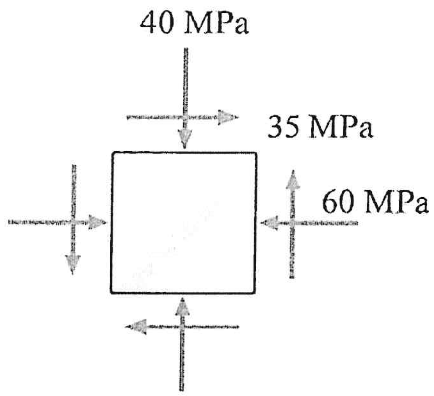


Figure 6: Plane State of Stress

(a) Draw and clearly label Mohr's Circle for the given state of stress, indicating all relevant stress points and axes.

(8 marks)

(b) Determine the orientation of the principal plane, θ_{P1} and θ_{P2}.

(8 marks)

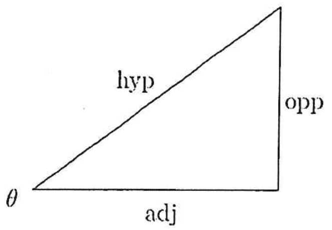
(c) Determine the principal stress σ_{max} , σ_{min}

(4 marks)

END OF EXAMINATION PAPER

LIST OF EQUATIONS

Basic Trigonometry:



$$\sin\theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

$$\cos\theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}}$$

CHAPTER 1 – STRESS

Normal stress,

$$\sigma = \frac{F}{A}$$

Shear stress

$$\tau = \frac{V}{A}$$

Cross sectional area:

Circle: $A = \pi r^2 = \frac{\pi}{4} d^2$

Rectangle: $A = length \times width$

Trapezium:

$$A = \frac{1}{2}(upper + bottom) \times height$$

Hollow circle / tube:

$$A = \pi\left(r_o^2 - r_i^2\right)$$

Factor of Safety:

$$F.S = \frac{\sigma_{fail}}{\sigma_{allow}}$$

$$F.S = \frac{\tau_{fail}}{\tau_{allow}}$$

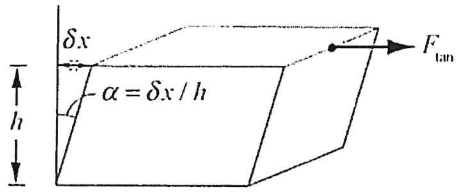
CHAPTER 2 – STRAIN

Normal strain:

$$\varepsilon = \frac{L - L_o}{L_o} = \frac{\delta}{L_o}$$

Shear strain:

$$\tan\alpha = \frac{\delta x}{h}$$



CHAPTER 3 – MECHANICAL PROPERTIES

$$\sigma = E \times \varepsilon$$

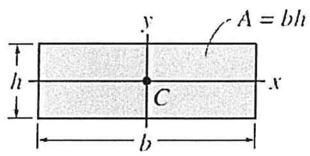
$$\frac{F}{A} = E \times \frac{\delta}{L_o}$$

CHAPTER 4 – BENDING

Maximum bending stress:

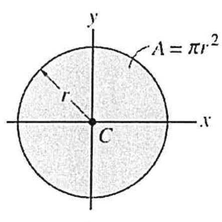
$$\sigma_{max} = \frac{M \times c}{I}$$

Moment of Inertia:



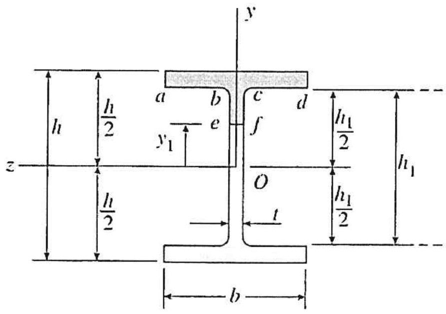
Rectangular area

$$I_x = \frac{1}{12} bh^3$$



Circular area

$$I_x = \frac{1}{4}\pi r^4$$



$$I = \frac{bh^3}{12} - \frac{(b-t)h_1^3}{12} = \frac{1}{12}(bh^3 - bh_1^3 + th_1^3)$$

CHAPTER 6 – TORSION

Torque:

$$T = F \times r$$

Shear stress in circular shaft:

$$\tau = \frac{T \times \rho}{J}$$

Maximum Shear stress in circular shaft:

$$\tau_{\max} = \frac{T_{\max} \times c}{J}$$

Polar moment of inertia:

$$J = \frac{\pi}{2} c^4 \quad \text{solid cross section}$$

$$J = \frac{\pi}{2}\left(c_o^4 - c_i^4\right) \quad \text{tubular cross-section}$$

Power:

$$P = T \times \omega$$

$$\omega = \frac{2\pi N}{60}$$

1 hp = 746 W

Angle of twist (in radians)

$$\phi = \sum \frac{T \times L}{J \times G}$$

CHAPTER 7 – COMBINED STRESSES

Stress components acting along x' and y' axes

$$\sigma_{x'} = \frac{(\sigma_x + \sigma_y)}{2} + \frac{(\sigma_x - \sigma_y)}{2}\cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\tau_{x'y'} = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy} \cos 2\theta$$

Principal Stresses

$$\sigma_{1,2} = \frac{(\sigma_x + \sigma_y)}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Orientation of Principal Planes, θ_p

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

Maximum in-plane shear stress

$$\tau_{\max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

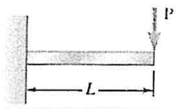
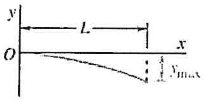
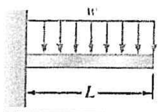
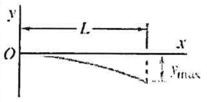
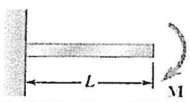
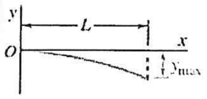
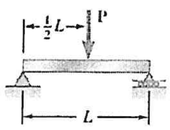
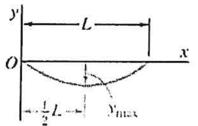
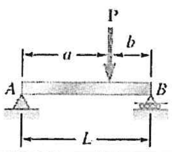
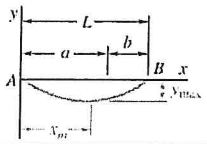
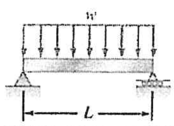
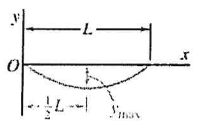
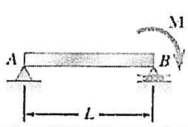
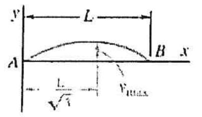
$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

Orientation of maximum in-plane shear stress, θ_s

$$\tan 2\theta_s = -\frac{(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

APPENDIX

F Beam Deflections and Slopes

Beam and Loading	Elastic Curve	Maximum Deflection	Slope at End	Equation of Elastic Curve
1 		$-\dfrac{PL^3}{3EI}$	$-\dfrac{PL^2}{2EI}$	$y = \dfrac{P}{6EI}(x^3 - 3Lx^2)$
2 		$-\dfrac{wL^4}{8EI}$	$-\dfrac{wL^3}{6EI}$	$y = -\dfrac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
3 		$-\dfrac{ML^2}{2EI}$	$-\dfrac{ML}{EI}$	$y = -\dfrac{M}{2EI}x^2$
4 		$-\dfrac{PL^3}{48EI}$	$\pm\dfrac{PL^2}{16EI}$	For $x \leq \frac{1}{2}L$: $y = \dfrac{P}{48EI}(4x^3 - 3L^2x)$
5 		For $a > b$: $-\dfrac{Pb(L^2 - b^2)^{3/2}}{9\sqrt{3}EIL}$ at $x_m = \sqrt{\dfrac{L^2 - b^2}{3}}$	$\theta_A = -\dfrac{Pb(L^2 - b^2)}{6EIL}$ $\theta_B = +\dfrac{Pa(L^2 - a^2)}{6EIL}$	For $x < a$: $y = \dfrac{Pb}{6EIL}[x^3 - (L^2 - b^2)x]$ For $x = a$: $y = -\dfrac{Pa^2b^2}{3EIL}$
6 		$-\dfrac{5wL^4}{384EI}$	$\pm\dfrac{wL^3}{24EI}$	$y = -\dfrac{w}{24EI}(x^4 - 2Lx^3 + L^3x)$
7 		$\dfrac{ML^2}{9\sqrt{3}EI}$	$\theta_A = +\dfrac{ML}{6EI}$ $\theta_B = -\dfrac{ML}{3EI}$	$y = -\dfrac{M}{6EIL}(x^3 - L^2x)$

MOHR'S CIRCLE