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## ***B.Tech. Degree II Semester Regular/Supplementary Examination in Marine Engineering June 2022***

**19-208-0206 MECHANICS OF SOLIDS  
(2019 Scheme)**

Time: 3 Hours

Maximum Marks: 60

**Course Outcome**

On successful completion of the course, the students will be able to:

CO1: Understand and apply the concept of stress and strain to analyze statically indeterminate and design structural members and machine parts.

CO2: Determine principal stresses strains and apply the concept of theories of failure for design.

CO3: Determine the stresses and strains in the members subjected to axial, bending and torsional loads

CO4: Evaluate the slope and deflection of beams subjected to loads.

CO5: Analyze and design thin, thick cylinders and springs.

Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 –Analyze,

L5 – Evaluate, L6 – Create

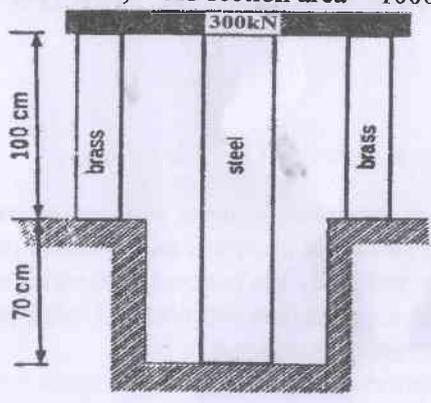
PO – Programme Outcome

- |                                                                                                                                                                                                                                                                                                                                                                                                                                             | (5 × 15 = 75) | Marks | BL | CO | PO    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------|----|----|-------|
| I. (a) Write down Hooke's Laws in tension and shear. How are the elastic moduli related?                                                                                                                                                                                                                                                                                                                                                    |               | 2     | L2 | 1  | 1.2.1 |
| (b) Following are the tension test data of a metal:<br>(i) Diameter of specimen = 30 mm<br>(ii) Load length = 200 mm<br>(iii) Load at elastic limit = 250 kN<br>(iv) Elongation over gauge length at 150 kN = 0.21 mm<br>(v) Maximum load = 380 kN<br>(vi) Total extension = 60 mm<br>(vii) Diameter of specimen at failure = 22.5 mm                                                                                                       |               | 5     | L2 | 1  | 1.3.1 |
| Determine:<br>(a) Young's Modulus<br>(b) Stress at elastic limit<br>(c) Percentage elongation<br>(d) Percentage decrease in cross section area.                                                                                                                                                                                                                                                                                             |               |       |    |    |       |
| (c) A steel tube 30 mm external diameter and 20 mm internal diameter encloses a copper rod of 15 mm diameter. Both are rigidly joined at ends. Calculate the stresses in the rod and tube when temperature is raised by 190°C. (E for steel = $2 \times 10^5$ MPa, E for copper = $1 \times 10^5$ MPa, Coefficient of thermal expansion: for steel = $11 \times 10^{-6}/^\circ\text{C}$ , for copper = $18 \times 10^{-6}/^\circ\text{C}$ ) |               | 8     | L3 | 1  | 1.2.1 |
| <b>OR</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |       |    |    |       |
| II. (a) Which are the theories of failure?                                                                                                                                                                                                                                                                                                                                                                                                  |               | 2     | L1 | 2  | 1.3.1 |
| (b) A circular bar 5 m long has 4 cm diameter and $E = 2.0 \times 10^5$ MPa. Determine the strain energy stored in the rod and maximum instantaneous elongation when a load of 60 kN is<br>(i) Gradually applied<br>(ii) Suddenly applied.                                                                                                                                                                                                  |               | 5     | L2 | 1  | 1.2.1 |

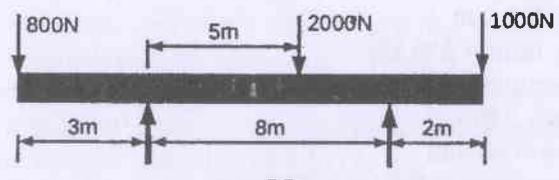
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Marks	BL	CO	PO
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- (c) Two brass rods and a steel rod together support a load of 300 kN as shown. Find stresses developed in the rods.  
 (for steel rod,  $E = 2 \times 10^5$  MPa, cross section area =  $1500 \text{ mm}^2$  ; for brass rod,  $E = 1 \times 10^5$  MPa, cross section area =  $1000 \text{ mm}^2$ )

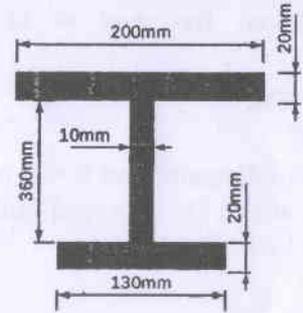


- III. (a) Describe:  
 (i) Cantilever beam  
 (ii) Simply supported beam  
 (iii) Fixed end beam  
 (iv) Continuous beam.  
 (b) Write down the bending equations and explain each term.  
 (c) Draw shear force and bending moment diagrams for the loaded beam shown.



OR

- IV. (a) A beam has uniform load intensity of  $q$ . Explain how the distributions of bending moment  $M$ , shear force  $F$  and  $q$  are related.  
 (b) A beam has rectangular cross section of 100 mm wide and 250 mm deep. It is subjected to a shear force of 50 kN at a section. Find the average shear stress and maximum shear stress at the section. Also, sketch the variations of shear stress across the section.  
 (c) A simply supported beam 10 m long carries a u.d.l of 20 kN/m: The cross section of the beam has dimensions as shown. Calculate the maximum bending stress and its location in the cross section.



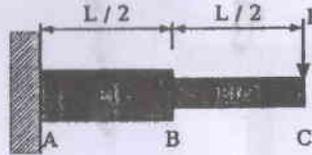
- V. (a) Write down the differential equation of the deflection curve of a beam. Show that the slope and deflection of loaded beam can be obtained using this equation.  
 (b) Describe moment-area method to find slope and deflection of a beam.

(Continued)

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Marks BL CO PO

- (c) A cantilever beam has point load  $P$  at the end as shown. Find the slope and deflection at the end. 8 L3 4 1.3.1



OR

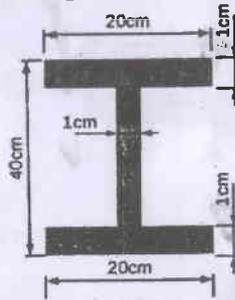
- VI. (a) What is *Macaulay's method* with regard to deflection of beams? Where is it used? 2 L1 4 1.3.1
- (b) A beam 6 m long is fixed at both ends, carries a load of 50 kN at its centre. Moment of inertia of cross section is  $78 \times 10^6 \text{ mm}^4$  and  $E = 2.1 \times 10^5 \text{ MPa}$ . Determine:  
 (i) Fixed end moments  
 (ii) Deflection under the load. 5 L2 4 1.3.1
- (c) A fixed beam AB of length 3 m carries a point load 45 kN at a distance of 2 m from end A. If the flexural rigidity ( $EI$ ) of beam is  $1 \times 10^4 \text{ kNm}^2$ , determine:  
 (i) Fixed end moments  
 (ii) Deflection under the load  
 (iii) Maximum deflection  
 (iv) Position of maximum deflection 8 L3 4 1.3.1
- VII. (a) With regard to shear stress distribution within the cross section of a solid circular shaft in torsion:  
 (i) Write down torsion formula and explain terms  
 (ii) Write down equation connecting torque and angle of twist and explain the terms. 2 L1 3 1.3.1
- (b) A solid shaft of 150 mm diameter transmits a torque of 20 kN-m. Calculate:  
 (i) The maximum shear stress introduced in the shaft  
 (ii) Maximum torque transmitted if permissible shear stress is 50 MPa. 5 L2 3 1.3.1
- (c) A tubular shaft has 3 m length, 72 mm and 43 mm outside and internal diameters. It transmits 450 kW at 120 rpm. Calculate the maximum shear stress and angle of twist in the shaft. ( $G = 83 \text{ MPa}$ ). 8 L3 3 1.3.1
- OR
- VIII. (a) Write down the expressions for the lowest critical loads with regard to buckling of a column in the following cases:  
 (i) Both ends hinged  
 (ii) One end free and other end fixed  
 (iii) Both ends are fixed  
 (iv) One end fixed and other end hinged. 2 L1 3 1.3.1
- (b) A solid round bar 3 m long and 5 cm in diameter is used as a column. Determine critical buckling load if:  
 (i) Both ends are hinged  
 (ii) Both ends are fixed.  
 ( $E = 2 \times 10^5 \text{ MPa}$ ) 5 L2 3 1.3.1

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Marks BL CO PO

- (c) A column 5 m long has the cross section as shown and both ends are fixed. Find the critical buckling load. ( $E = 2.1 \times 10^5 \text{ Mpa}$ )



- IX. (a) If a thin cylindrical shell closed at both ends is subjected internal pressure:
- Define hoop stress and longitudinal stress
  - Write down expressions for both these stresses.
- (b) A spherical vessel 1.5 m diameter is subjected to an internal pressure of 2.0 MPa. Find the thickness of the shell required if maximum stress is not to exceed 150 MPa and joint efficiency is 75%.
- (c) A thin cylindrical shell has length = 3.0 m, internal diameter = 1 m, wall thickness 15 mm,  $E = 2 \times 10^5 \text{ MPa}$  and Poission's ratio = 0.3. It is subjected to internal pressure of 1.5 MPa. Calculate hoop stress, longitudinal stress and change in diameter.
- OR**
- X. (a) Define thin and thick cylinders. Sketch how the hoop stress varies across shell thickness in thick cylinders.
- (b) Determine minimum and maximum hoop stress across the shell thickness of a thick cylinder 40 cm internal diameter and 10 cm shell thickness. The internal pressure is 9.0 MPa.
- (c) A closely coiled helical spring of spring constant 20 N/mm is to carry a load of 500 N. It's mean coil diameter is 10 times that of the wire diameter. Permissible shear stress is 80 MPa. Calculate:
- Mean coil diameter
  - Wire diameter
  - Number of coils ( $G = 86.0 \text{ MPa}$ )

Blooms's Taxonomy Levels  
L1-12%, L2-35%, L3-53%

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