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| Indian Maritime University | | | | |
| (A Central University, Govt of India) | | | | |
| Supplementary Examinations – March/April 2025 | | | | |
| Programme Name: B Tech (Marine Engineering) | | | | |
| Semester: III | | | | |
| Subject Code: UG11T4302 | | | | |
| Subject Name: SOLID MECHANICS | | | | |
| Date : 22.03.2025 | | | Max Marks : 70 | |
| Duration : 03 Hrs | | | Pass Marks : 35 | |
| Part A (Part A is Compulsory) | | | | |
| Q1 [10 x 1 = 10 Marks] Multiple Choice Questions | Options | | | |
| (1) The property of a material by virtue of which a body returns to its original shape after removal of the load is known as | A) ductility | B) plasticity | C) elasticity | D) resilience |
| (2) The ratio of modulus of rigidity to modulus of elasticity for a poisson's ratio of 0.25 would be | A) 0.5 | B) 0.4 | C) 0.3 | D) 1 |
| (3) If D is the diameter of a thin spherical vessel, then volumetric strain is equal to | A) two times the strain of diameter | B) 1.5 times the strain of diameter | C) three times the strain of diameter | D) the strain of diameter |
| (4) The shear stress at any point of a shaft, subjected to twisting moment, is | A) proportional to its distance from the central axis of the shaft | B) inversely proportional to its distance from the central axis of the shaft | C) proportional to the square of its distance from the central axis of the shaft | D) none of the above |
| (5) The hoop or circumferential stress in a thin cylindrical shell of diameter (D), length (L) and | A) $pD/4t$ | B) $pD/2t$ | C) $2pD/t$ | D) $4pD/t$ |

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| thickness (t), when subjected to an internal pressure (p) is equal to | | | | |
| (6) In case of bi-axial state of normal stress. The shear stress on a maximum normal stress plane | A) sum of normal stress | B) difference of normal stress | C) half of sum of normal stress | D) zero |
| (7) Volumetric strain of cylindrical boiler under steam pressure in terms of circumferential (ϵ_h) and longitudinal strains (ϵ_l) is given as | A) $\epsilon_h + \epsilon_l$ | B) $\epsilon_h * \epsilon_l$ | C) $2 * \epsilon_h + \epsilon_l$ | D) $2 * \epsilon_l + \epsilon_h$ |
| (8) When a helical compression spring is cut into two equal halves, the stiffness of each of the resulting spring will be | A) unaltered | B) double | C) one-half | D) one-fourth |
| (9) The periodic time of a body moving with simple harmonic motion | A) depends upon its amplitude under all conditions. | B) is independent of its amplitude | C) depends upon its amplitude under certain conditions | D) has no relation with its frequency |
| (10) The maximum displacement of a body moving with simple harmonic motion from its mean position is called | A) oscillation | B) amplitude | C) Beat | D) none of the above. |
| Q2 [2 x 5 = 10 Marks] - Short Answer Type Questions | | | | |
| (11) What happens to stress and strain values in the plastic zone of material when loading acting on a material | | | | |
| (12) If E, G and K denote Young's modulus, Modulus of rigidity and Bulk modulus respectively for an elastic material, then find the value of E when G = 3 and K = 5. | | | | |

(13) Define proof resilience and modulus of resilience.

(14) A body is subjected to a pure tensile stress of 100 units. What is the maximum shear stress produced in the body at some oblique plane due to the above?

(15) Define the amplitude and frequency of a simple harmonic motion

Part B (Answer any Five out of Seven) Each Question is for 10 Marks

16. Consider a steel tube surrounding a solid aluminum cylinder, the assembly being compressed between rigid cover plates by centrally applied forces as shown in Fig. 1. The aluminum cylinder is 8 cm in diameter and the outside diameter of the steel tube is 9.2 cm. If $P = 200$ kN, find the stress in the steel and also in the aluminum. For steel, $E = 200$ GPa and for aluminum $E = 80$ GPa.

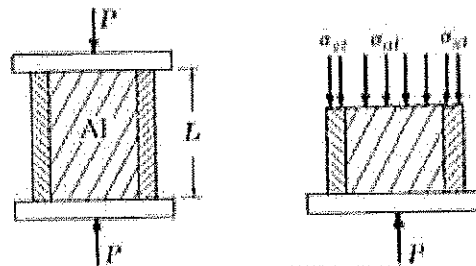


Figure.1

17. A plane element is subject to the stresses shown in Fig. 2. Determine

(a) the principal stresses and their directions. (6 Marks)

(b) the maximum shearing stresses and the directions of the planes on which they occur. Use the analytical approach. (4 Marks)

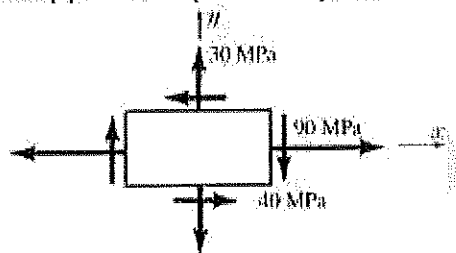


Figure. 2

18. A specimen of steel 20 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.25 mm under a load of 80 kN and the load at elastic limit is 102 kN. The maximum load is 130 kN. The total extension at fracture is 56 mm and diameter at neck is 15 mm. Find

(i) The stress at elastic limit.

(ii) Young's modulus.

(iii) Percentage elongation.

(iv) Percentage reduction in area.

(v) Ultimate tensile stress

19. A metallic bar 300 mm X 100 mm X 40 mm is subjected to a force of 5 kN (tensile), 6 kN (tensile) and 4 kN (tensile) along x, y and z directions respectively as shown in Fig. 3. Determine the change in the volume of the block. Take $E = 2 \times 10^5$ N/mm² and Poisson's ratio = 0.25.

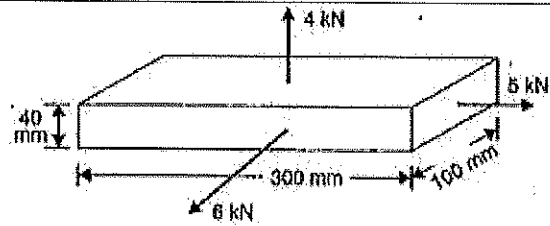


Figure. 3

20. Derive the maximum torque transmitted by a circular solid shaft.
21. A solid steel shaft of 60 mm diameter is to be replaced by a hollow steel shaft of the same material with an internal diameter equal to half of the external diameter. Find the diameters of the hollow shaft and saving in material, if the maximum allowable shear stress is same for both shafts.
22. The weight of an empty railway wagon is 240 kN. On loading it with goods weighing 320 kN, its spring gets compressed by 80 mm.
- (a) Calculate its natural period of vibrations when the railway wagon is (i) empty and (ii) loaded as above. (5 Marks)
- (b) It is set into natural vibrations with an amplitude of 100 mm when empty. Calculate the velocity of the railway wagon when its displacement is 40 mm from the statical equilibrium position (5 Marks)

T.M.M