B.E./B.TECH. Degree Examination, December 2020

Third Semester

ME18304 – MECHANICS OF SOLIDS

(Regulation - 2018)

Time: Three hours Maximum : 80 Marks

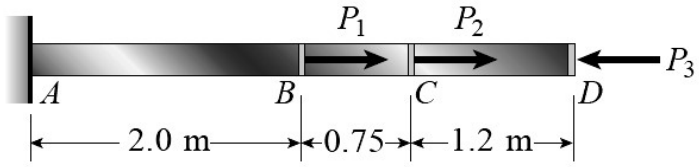
Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Three bars with different diameter and different length is attached in series from the fixed end. An axial load 'P' is applied at free end. What is the magnitude of load carried by each bar individually?
   (a) 3P
   (b) P/3
   (c) P
   (d) Insufficient data
2. A rectangular beam 400 mm deep is simply supported over a span of 5 m. If the bending stress is not to exceed 120 MPa and given I = 230×10^6 mm^4 then the uniformly distributed load carried by the beam in kN/m will be
   (a) 90
   (b) 82
   (c) 34
   (d) 44
3. A motor shaft consists of a tube 50 mm external diameter and 4 mm thick. The engine develops 12 kW at 2000 rpm. If the power is transmitted through 4:1 gearing, then the maximum stress (MPa) in the tube will be
   (a) 4.65
   (b) 18.67
   (c) 8.23
   (d) 9.33
4. A thin cylindrical shell, 2 m long has 300 mm diameter and thickness of metal 10 mm. It is completely filled with water at atmospheric pressure. Values of Young's modulus and Poisons ratio for the shell material is 2×10^5 N/mm^2 and 0.3 respectively. If an additional 30,000 mm^3 of water is pumped in, pressure (in MPa) developed in the vessel is
   (a) 1.489
   (b) 1.786
   (c) 2.525
   (d) 2.932
5. Justify the use of factor of safety with an example?
6. Why hollow circular shafts are preferred when compared to solid circular shafts in torsional loads?
7. When comparing circle, rectangle, square and I section, which will be the suitable one for bending loads? Why?
8. If Stress in X axis and Y axis are 50 MPa (tensile) and 70 MPa (compressive). What will be the radius of the Mohr's circle? Draw a rough sketch and explain?

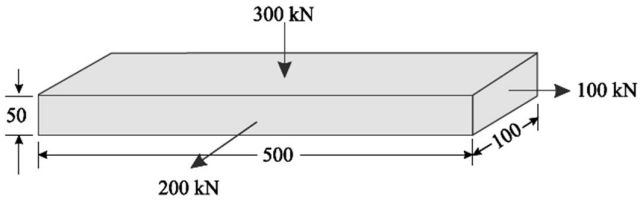
PART B - (4 X16 = 64 marks)

09. (a) A brass rod (E = 110 GPa) with cross sectional area of 250 mm^2 is loaded by forces P_1 = 15 kN, P_2 =10 kN, and P_3 = 8 kN. Segment lengths of the bar are as shown in figure in meters. Find the change in length of the bar. Compare the change in length of the bar, if it is replaced to a mild steel rod of E = 205 GPa. Justify which material is better for the given problem. **(16)**



(OR)

(b) A rectangular bar 500 mm long and 100 mm × 50 mm in cross-section is subjected to forces as shown in figure. **(16)**



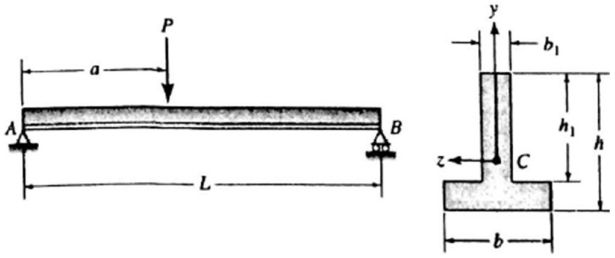
What is the change in the volume of the bar? Take Bulk modulus for the bar material as 133.34 GPa and Poisson's ratio as 0.25.

10. (a) A double sided overhanging beam of length 10 m is symmetrically supported such that the distance between the supports are 6 m. It has a point load of 3 kN at the left end and 5 kN at the right end. The beam also carries a UDL of 2 kN/m between the supports. Draw the Shear force and Bending Moment diagram and also locate the points of contraflexure. **(16)**

(OR)

(b) A simple beam AB with a T cross section carries a concentrated load P as shown in figure. Determine the maximum tensile stress and largest compressive stress in the member. **(16)**

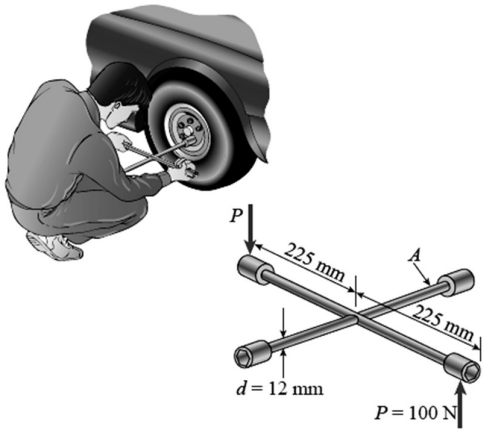
Assume P = 6 kN, L = 3 m, a = 1 m, b = 75 mm, b_1 = 25 mm, h = 100 mm and h_1 = 75 mm



11. (a) While removing a wheel to change a tire, a driver applies forces P = 100 N at the ends of two of the arms of a wrench (see figure). The wrench is made of steel with shear modulus C = 78 GPa. Each arm of the wrench is 225 mm long and has a solid circular cross section of diameter d = 12 mm. **(16)**

(a) Determine the maximum shear stress in the arm that is turning the lug nut (arm A).

(b) Determine the angle of twist (in degrees) of this same arm.



(OR)

(b) The A-36 hollow steel shaft is 2 m long and has an outer diameter of 40 mm. When it is rotating at 80 rad/s, it transmits 32 kW of power from the engine E to the generator G. Determine the smallest thickness of the shaft if the allowable shear stress is 140 MPa and the shaft is restricted not to twist more than 0.05 rad. **(16)**

12. (a) An empty cylindrical vessel of dimension 1.8 m long, 800 mm in diameter is made up of 8 mm thick plates. An oil is pumped to the vessel till the pressure reading shows 25 bar. If the hoop and longitudinal stresses in the vessel are 130 MPa and 65 MPa respectively, will the vessel withstand the pressure of oil? Justify? Also find the changes in length, diameter and volume of the vessel for the fluid pressure. Take E = 200 GPa and Poisson's ratio 0.3 **(16)**

(OR)

(b) A plane element of a body is subjected to a tensile stress of 300 MPa in x-x direction and a tensile stress of 200 MPa in the y-y direction. Each of the above stresses is subjected to a shear stress of 100 MPa such that it tends to rotate the element in a clockwise direction. Find analytically the normal and shear stresses on a plane inclined at an angle of 60° with the x-x axis. Also verify the same graphically. **(16)**

If the inclined plane is 70° instead of 60°, what will happen to the normal and shear stresses? (Note: Graphical method not required for 70° inclination)