Code No: R22031 **R10** SET - 1

II B. Tech II Semester Regular Examinations, August - 2014
MECHANICS OF SOLIDS
(Com. to ME, AME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Define Bulk modulus. Derive a relation between young's modulus of elasticity and bulk modulus.
   b) An assembly of a steel bar of 70 mm diameter enclosed in an aluminium tube of 80 mm internal diameter and 120 mm external diameter is compressed between two rigid parallel plates by a force of 400 kN. The length of the assembly is 1 m. Determine the stresses in the tube and the bar if the young's modulii of elasticity of steel and aluminium are 200 GPa and 80 GPa respectively. (7M+8M)

2. a) Derive the relation between shear force and rate of loading.
   b) Draw shear force and bending moment diagrams for a beam of 6 m long and loaded as shown in Fig.1 and indicate the main values. (4M+11M)

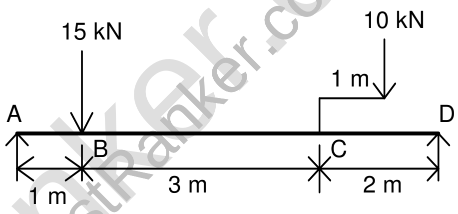

Fig. 1

3. a) What are the assumptions made in the theory of simple bending?
   b) A simply supported beam made of cast iron has a length of 1 m and a square cross section of 20 mm size. The beam fails on applying a load of 400 N at mid span. Find the maximum uniformly distributed load that can be applied safely to a 50 mm wide x 80 mm deep cross section and 1.5 m long cantilever made of the same material as that of the simply supported beam. (4M+11M)

4. a) What are the assumptions taken in the analysis of shear stress in beams?
   b) Determine the maximum shear stress in a beam with rectangular cross-section of depth D and width B if a shear force F acts on the section. Also compare it with its mean shear stress. (4M+11M)
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5. a) What are statically determinate and statically indeterminate frames?
   b) Determine the forces in all the members of the frame shown in Fig. 2. Use method of joints. (4M+11M)

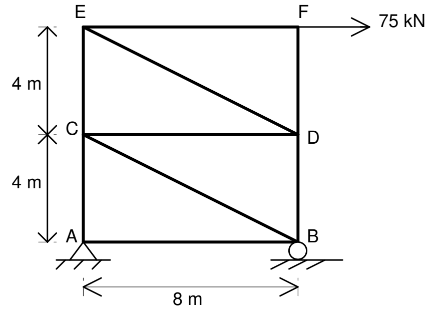

Fig. 2

6. a) Derive the differential equation for the elastic line of a beam subjected to deflection.
   b) Obtain the deflection equation for the beam shown in Fig. 3. The length of the beam is L and the flexural rigidity is EI. Use Macaulay's method. (15M)

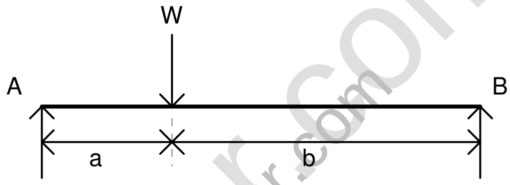

Fig. 3

7. a) Drive an expression for volumetric strain in a thin cylinder subjected to an internal pressure p. The ends of the cylinder are closed by circular plates.
   b) A thin cylinder of 250 mm inside diameter and 3 mm thick has its ends closed by rigid plates. It is filled with water under pressure. If an external axial pull of 50 kN is applied to the ends, the water pressure falls by 0.1 MPa. FInd the value of poisson's ratio if the bulk modulus is 2000 MPa young's modulus is 150 GPa. (5M+10M)

8. A steel cylinder of 300 mm external diameter is to be shrunk on to another steel cylinder of 150 mm internal diameter. After shrinking, the diameter at the junction is 250mm and radial pressure at the common junction is 30 N/mm^2. Find the original difference in radii at the junction. Take young's modulus as 200 GPa. (15M)

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1. a) Derive the relationship among the three elastic modulii.
   b) A composite bar made up of aluminium and steel is rigidly attached to the end supports as shown in Fig 1. Find the stresses in the two portions of the bar when it is heated to a temperature of 80°C from 20°C when (i) the ends do not yield (ii) the ends yield by 0.3 mm. The young's modulii of elasticity for steel and aluminium are 200 GPa and 80 GPa respectively. Coefficients of expansion for steel and aluminium are: $\alpha_{steel} = 11.7 \times 10^{-6} /^{o}C$ and $\alpha_{aluminium} = 23.4 \times 10^{-6} /^{o}C$; Cross sectional areas of aluminium bar and steel bar are 250 mm^2 and 375 mm^2 respectively. (7M+8M)

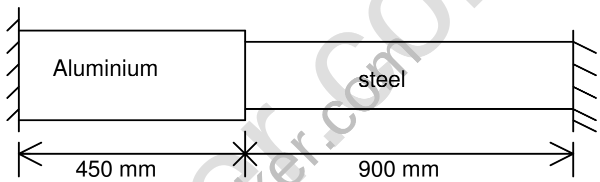

Fig. 1

2. Draw shear force and bending moment diagrams for the beam shown in Fig. 2. Determine the magnitudes and locations of maximum bending moment for the portions of the beam AB, BC and CD. (15M)

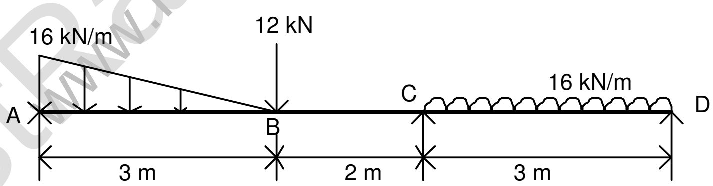

Fig. 2

3. Derive the bending equation according to the theory of simple bending. (15M)

4. A 60 mm wide and 120 mm deep I-beam is acted upon by a shear force of 10 kN. The web thickness is 4 mm and the flange thickness is 6 mm. Determine the tranverse shear stress neutral axis and at the top of the web. Also find the ratio of the maximum shear stress to the mean stress based on the assumption of uniform distribution over the web. What is the percentage of shear force carried by the web? Take the moment of inertia of the section as 2.2×10^6 mm^4 and the area is 960 mm^2. (15M)
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5. a) Explain the terms: i) perfect frame ii) deficient frame iii) redundant frame
   b) Determine the forces in all the members of the frame shown in Fig. 3.Use method of joints. (3M+12M)

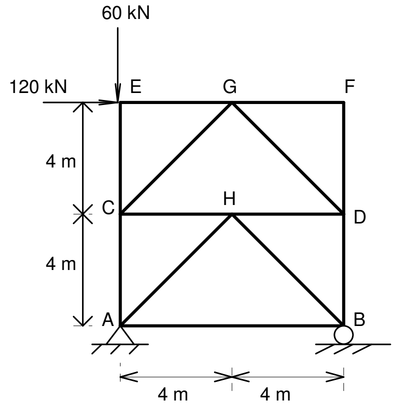

Fig. 3

6. A simply supported beam of length L carries a concentrated load of P at a distance L_1 from one end. Determine i) the deflection under the load ii) maximum deflection iii) slopes at the two ends. Use Moment-area method. (15M)

7. a) A spherical tank for storing gas under pressure is 30 m in diameter and is made of structural steel of 20 mm thick. The yield strength of the material is 250 MPa and the factor of safety is 2.5. Determine the maximum permissible internal pressure, assuming the welded seams between various plates are 80 percent as strong as the solid metal.
   b) A copper tube of 75 mm internal diameter, 1 m long and 3 mm thick is filled with water under pressure. Find the change in pressure if additional volume of 3000 mm^3 of water is pumped into the tube. Assume that there is no distortion of end plates. Take young's modulus as 100 GPa, bulk modulus as 2000 MPa and poisson's ratio as 0.25. (5M+10M)

8. A cylinder of external diameter 300 mm and internal diameter 250 mm is shrunk over another cylinder of external diameter of 250 mm and internal diameter 200 mm. The radial pressure at the junction after shrinking ia 10 N/mm^2. Find the final stresses set up across the section, when the compound cylinder is subjected to an internal pressure of 90 N/mm^2. (15M)

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1. a) Draw stress-strain curve for steel. Explain its salient features.
   b) A 30mm thick and 200mm wide steel plate tapers uniformly to 20mm thickness and 150 mm width over a length of 2 m. Determine the increase in length when a pull of 20 kN is applied Take young's modulus of elasticity as 210 GPa. (7M+8M)

2. Draw shear force and bending moment diagrams for the beam shown in Fig. 1 and indicate the main values. (15M)

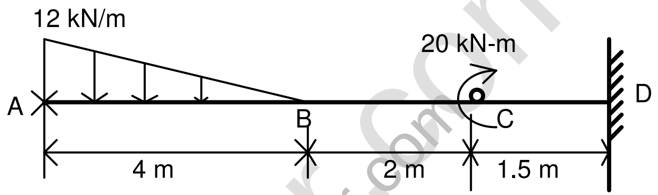

Fig. 1

3. The tension flange of a girder of I-section is 200 mm x 40 mm, whereas the compression flange is 150 mm x 20 mm. The web is 300 mm deep and 20 mm thick. If the girder is used as simply supported beam of 10 m span, determine the load per unit run if the allowable stress is 100MPa in compression and 40 MPa in tension. (15M)

4. Determine the maximum shear stress induced in a beam with the following cross-sections when subjected a shear force of F. compare it with its mean stress.
   a) Square cross section with the diagonal horizontal and the length of the diagonal is B.
   b) Triangular cross section with its depth D and base W. (8M+7M)
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Code No: R22031 **R10** SET - 3

5. a) What are the assumptions made in the analysis of frames and trusses?
   b) Determine the forces in the members CE, GE and GB of the frame shown in Fig. 2 using method of sections. D and E are the mid points of AC and BC respectively. (6M+9M)

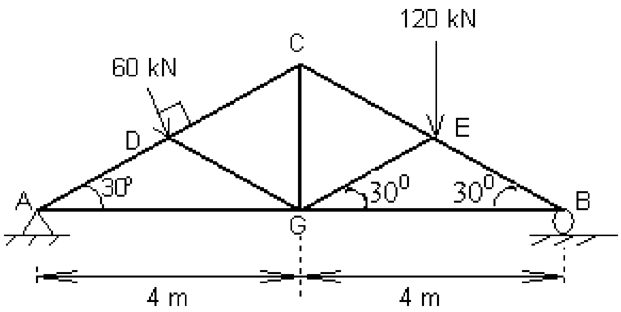

Fig. 2

6. Determine the deflection at the points B and C of the beam shown in Fig. 3. The flexural rigidity of the beam is 90,000 kN-m^2. Use double integration method. (15M)

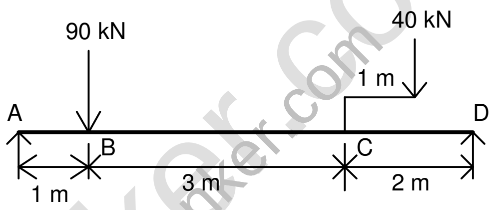

Fig. 3

7. a) What are the assumptions made in the analysis of thin cylinders? Derive the expressions for hoop and longitudinal stresses developed in them.
   b) A cylindrical boiler drum has hemispherical ends. The cylindrical portion is 1.5 m long and 720 mm in diameter and 18 mm thick. It is filled with water at atmospheric pressure. Determine the volume of additional water required to be filled in the drum to raise the pressure in the drum to 12 MPa. Assume the hoop strain at the junction of cylinder and the hemisphere to be the same for both. Take young's modulus of elasticity as 200 GPa, Bulk modulus as 2100 MPa and poisson's ratio as 0.3. (6M+9M)

8. a) Derive Lame's equations.
   b) Determine the thickness of metal necessary for a thick cylindrical shell of internal diameter 160 mm to withstand an internal pressure of 10 N/mm^2. The maximum hoop stress in the section is not to exceed 40 N/mm^2. (8M+7M)

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1. a) A bar of 3 m long and 15mm diameter, hangs vertically and has a collar attached at the lower end. Determine the maximum stress induced when a weight of 100 kg falls through a height of 20 mm on to the collar.
   b) A steel bar of 15 mm diameter is subjected to an axial load of 15 kN. If the change in diameter is found to be 0.0024 mm, determine the poisson's ratio, modulus of elasticity and bulk modulus. Take rigidity modulus as 78 GPa. (6M+9M)

2. Draw shear force and bending moment diagrams for the overhanging beam shown in Fig. 1and indicate the main values. (15M)

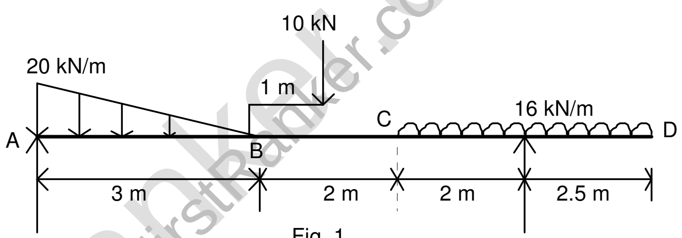

Fig. 1

3. a) A 300 mm x 80 mm I-beam is to be used as a simply supported beam of 7 m span. The web thickness is 10 mm and the flanges are 15 mm thickness. Determine the magnitude of concentrated load that can be carried at a distance of 3 m from one support if the maximum permissible stress is 90 MPa.
   b) Compare the bending resistances of a beam with square cross section placed with two sides horizontal to that with a diagonal horizontal for the same stress in each case. (10M+5M)

4. Determine the shear stress induced in a beam at its neutral axis with the following cross-sections when subjected a shear force of F. compare it with its mean stress.
   i) Hexagonal cross section with two parallel sides horizontal and the length of each side is B.
   ii) Circular cross section of diameter D. (8M+7M)
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SET - 4

5. Determine the value of the force P which produces a force 200 kN in the member AB of the cantilever frame shown in Fig. 2. Also determine the forces in the members GH and AG.(15M)

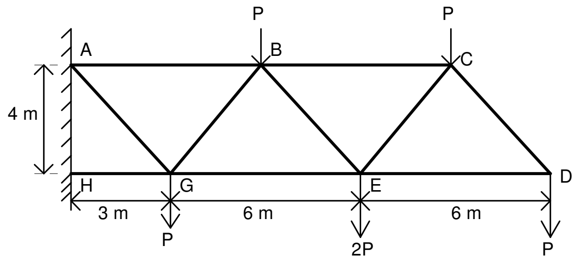

Fig. 2

6. Determine the deflection at the free end of the beam shown in Fig. 3 and the maximum deflection between A and B. Assume young's modulus of elasticity as 200 GPa and I = 12 x 10^6 mm^4. (15M)

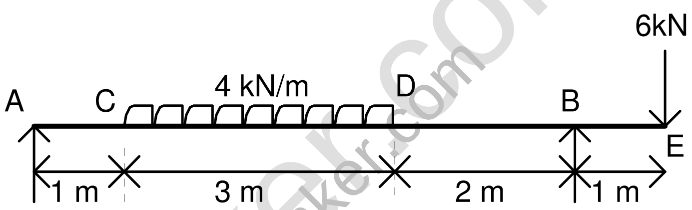

Fig. 3

7. a) What are the stresses developed in a thin spherical shell and find the expressions for the stresses and volumetric strain.
   b) A thin spherical steel shell of 1.5 m diameter and uniform thickness is filled with water at a pressure of 2.5 MPa. The relief valve attached to the shell is opened to allow the water to escape until the pressure inside the shell drops to atmospheric pressure. If the volume of water escaped is 4500 c.c., determine the thickness of the plates of the shell. Take young's modulus of elasticity as 200 GPa, Bulk modulus as 2100 MPa and poisson's ratio as 0.3. (5M+10M)

8. A steel tube of 200 mm external diameter is to be shrunk onto another steel tube of 60 mm internal diameter. The diameter at the junction after shrinking is 120mm. The difference of diameters at the junction is 0.09 mm before shrinking on. Calculate the radial pressure at the junction and the hoop stresses developed in the two tubes after shrinking on. Take young's modulus of elasticity as 200 GPa. (15M)