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ET-502(A)

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B.Tech. Civil (Construction Management) / (Water Resources Engineering)

Term-End Examination

December, 2011

ET-502(A) : STRENGTH OF MATERIALS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any five** questions. All questions **carry equal** marks.*

1. (a) Define following elastic constants. **6**

(i) Modulus of elasticity

(ii) Modulus of rigidity

(iii) Poisson's ratio

How many elastic constants exist independently for an elastic isotropic material. Give relationship among constants.

(b) The modulus of elasticity, E and Poissons ratio υ of a material are respectively 2.1×10^5 N/mm^2 and 0.3. A cube of side edge 10 mm made of this material is immersed in water to a depth of 120 m. Find change in volume of the cube. **8**

2. (a) State theories of failure (Principal stress theory, Shear stress theory, Total strain energy theory and Distortion energy theory). **6**

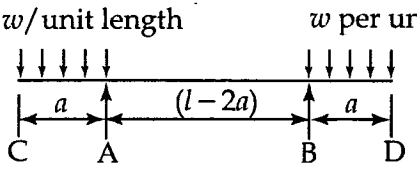
(b) The principal stresses with respect to principal axes at a point are given by $\sigma_{P1} = 300$ N/mm^2 and $\sigma_{P2} = 150$ N/mm^2. Examine if the body is safe under four theories of failure. 8

3. The vertical plane through a point in a stressed region carries a normal stress of 100 N/mm^2 (tensile) and an unknown shearing stress. The maximum principal stress at the point is 150 N/mm^2 and the maximum shearing stress is 120 N/mm^2. Determine direct stress, σ_{yy} on horizontal plane, Minimum principal stress, σ_{p2}, shearing stress on vertical and horizontal planes, τ_{xy}. Also determine the orientation of principal planes and plane of maximum shearing stress. Show states of stress on the sketch. 14

4. The drum of a boiler is made from 20 mm thick steel plate with internal diameter of 1.2 m and length of 3 m. The operating pressure of 1.0 MPa is brought by pumping water after the drum is full. Calculate the volume of water to be pumped in. E for steel is 2.1×10^5 MPa, $\upsilon = 0.28$. Bulk modulus K for water is 2.4×10^3 MPa. 14

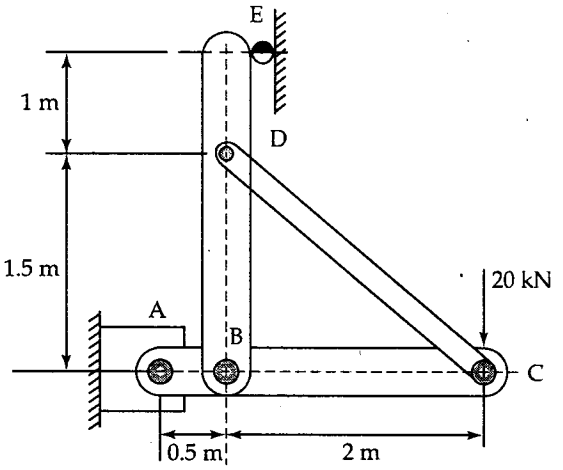
5. A solid and a hallow shaft have same weight and made in same material. The inner diameter of hallow shaft is half of outer diameter. Show that for same shearing stress the hallow shaft will carry 1.442 times the torque carried by solid shaft. Is the greater torque capacity of hallow shaft an advantage ? 14

6. For the beam shown in figure draw SFD and BMD. The beam has a rectangular section 14



50 mm wide × 5 mm deep. If $w = 2$ N/mm, $a = 200$ mm, E for beam material is 2.1×10^5 N/mm^2, find maximum bending stress and radius of curvature of part AB.

7. The member CD and pin B in structure shown below are made of structural steel for which yield strength in tension and compression are 250 N/mm^2. Yield strength in shear is 125 N/mm^2. Calculate factors of safety for member CD and pin B if diameters of CD and pin are 20 mm each. The pin B is in single shear. 14



8. (a) What are four different end conditions of struts ? Sketch four struts with different end conditions and mention their equivalent lengths. 6

(b) A steel strut 1.22 m long is square cross-section of edge 12.5 mm. The strut has rounded ends and carries axial load. Calculate Euler buckling load for the strut. Take $E = 203$ kN/mm^2. Another column in aluminium is made to have same length and same pivoted support. What will be the size of the square section of aluminium column if it has to have same weight as steel column ? The densities of steel and aluminium respectively are 78600 N/m^3 and 27100 N/m^3. Calculate the Euler bucking load for aluminium strut if $E = 70$ kN/mm^2. 8