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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*A Constituent Institution of Manipal University*

**III SEMESTER B.TECH. (MECHATRONICS ENGINEERING)**

**END SEMESTER EXAMINATIONS, NOV 2017**

SUBJECT: STRENGTH OF MATERIALS [MTE 2102]

**REVISED CREDIT SYSTEM**
**(21/11/2017)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Data not provided may be suitably assumed

**1A** A hollow steel shaft is subjected to a torque of 45 kNm. If the angle of twist is 0.5° per meter length of the shaft, and the shear stress is not allowed to exceed 90 $MN/m^2$. Take G= 84 $kN/mm^2$ **04**

a. Suggest a suitable diameter (inside diameter is 50% of outside diameter)
b. Is there any change in angle of twist or shear stress? If so what is the magnitude?

**1B** A round compression member with both ends pinned and made of cold drawn steel (Yield stress =441 MPa, E=207 GPa) is to be used in a machine. It has a diameter of 25 mm and length of 950 mm. Calculate the critical buckling load. Also compute the allowable load on the column considering a factor of safety N=3. **04**

**1C** A ship propeller shaft is shown in Fig Q1C. What are the stresses acting on the shaft? How will you calculate the stresses? **02**

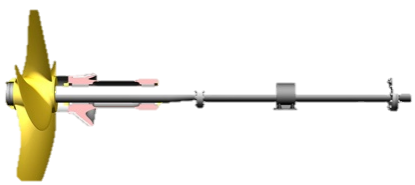

**Fig Q1C**

**2 A** A steel shaft 40 mm in diameter is subjected to a torque of 1200 Nm and a bending moment M so as to cause failure in it. If allowable stress for the shaft material is 225 $N/mm^2$, determine the magnitude of M according to both maximum principal stress theory and maximum shear stress theory. **04**

**2B** A material is loaded as shown in Fig Q2B. Determine the principal stresses, principal planes, maximum shear stress and angle of plane of maximum shear stress. **06**

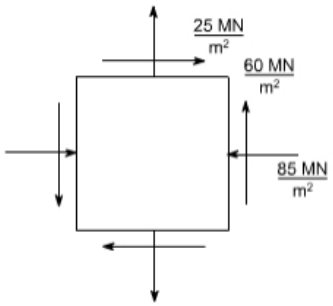


**Fig Q2B**

**3A.** A shortwave radio antenna is fixed to a hollow aluminium tube as shown in Fig Q3A. During installation, a force of 100N is applied to the end of the antenna as shown. Calculate the inner and outer diameters of the tube if allowable stress of the tube is 130 MPa. The tube is supported at the clamps and assume that rotation is not permitted. Use maximum shear stress theory. Inside diameter is 75% of outside diameter. **05**

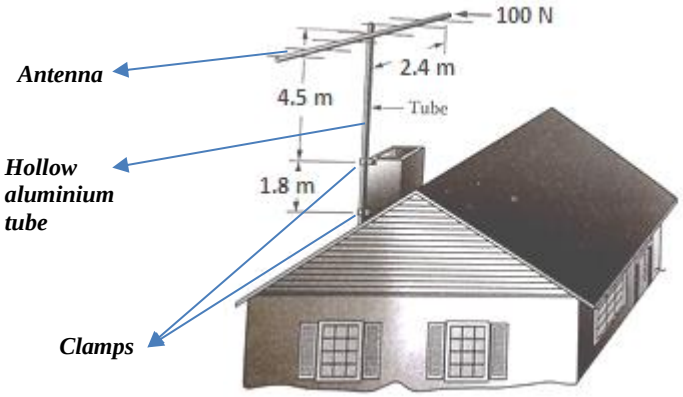


**Fig Q3A**

**3B.** A beam is to be made of a rectangular section to carry static load shown in Fig 3B and is supported at B and C. The details of cross section are also shown. Specify a suitable height for the cross section. The material has an allowable bending stress of 300 N/mm$^2$. **05**

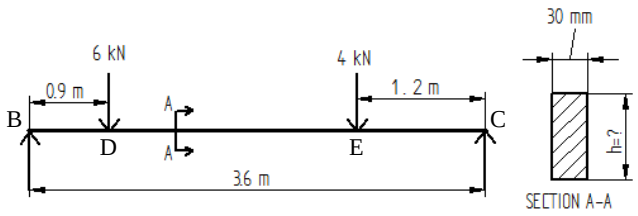


**Fig Q3B**

**4A** In an amateur theatre production, a pirate is to "walk the plank". **06**

*(Walk the plank is an execution method usually used in ships to people who do not know how to swim. In this method, the person is blindfolded and asked to walk on the plank until he falls off).*

The manufacturer of the plank has suggested that, at any point, if the deflection of the plank due to bending exceeds 15 mm, the plank will break. For the arrangement shown and the pirates current position as shown in Fig Q4A, will the plank fail if the pirate weighs 1000 N? If yes what is the distance from the ship (support C) where the plank will start to deflect more than 15 mm? Take E=12 GPa, I=3.16X10$^{-5}$ m$^4$

Consider the two supports (A and C) on the ship to be simply supported.

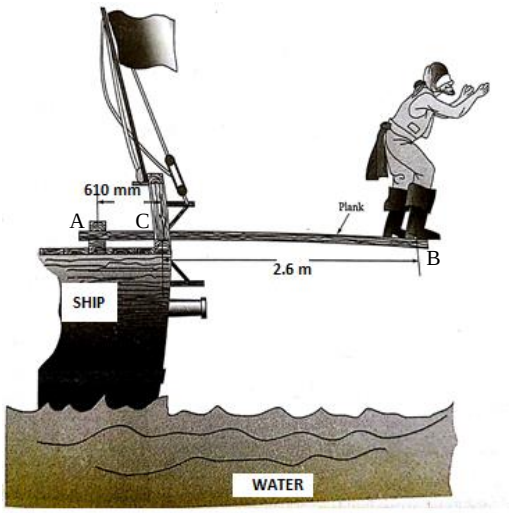


**Fig Q4A**

**4B** A hollow square cantilever beam is loaded at two points as shown in Fig 4B. If the stress in plane C-C should not exceed 125 MPa, what should be the total length of the cantilever beam? The hollow beam has an outer dimension of 200 mm X 200 mm and inner dimensions of 100 mm X 100 mm. Take L1=L2 **04**

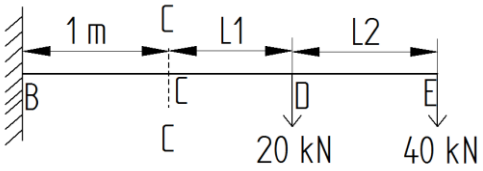


**Fig Q4B**

**5A** Compute the angle of twist of the free end relative to the fixed end of the steel bar shown in Fig Q5A. Take G=80 kN/mm$^2$ **04**

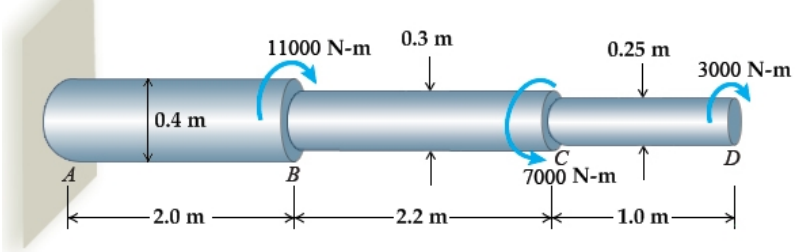

**Fig Q5A**

**5B** A picnic table in a park is made by supporting a circular top on an aluminium tube which has an allowable stress of 20 MPa and is rigidly held in the ground as shown in Fig Q5B (b). If a person weighing 1350 N sits on the table as shown in Fig Q5B(a), justify whether the tube will fail or no with proper mathematical reasoning. The tube and table dimensions are shown in the Fig Q5B(b). What is the magnitude of maximum stress in the tube? **03**

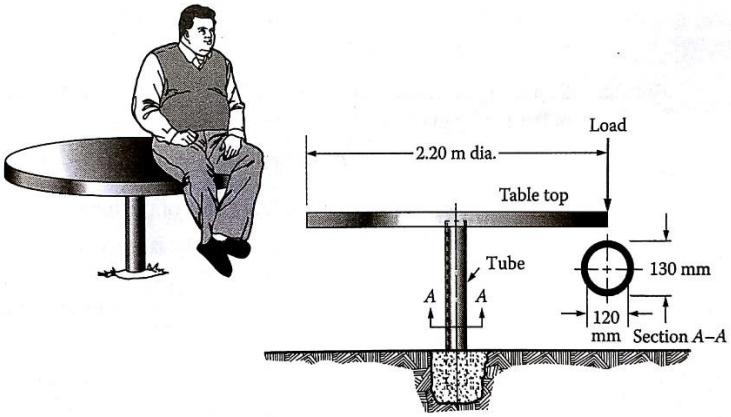


**Fig Q5B**

**5C.** A column is 2m long and has a rectangular cross section 30mm X 20mm. The bottom is built into a ground socket and the top is completely unrestrained. Given E= 200GPa, calculate the buckling load using Eulers formula. **03**