Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: STRENGTH OF MATERIALS [MME 2102]

REVISED CREDIT SYSTEM
(28/11/2015)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. A beam of 3m span is loaded as shown in Fig Q1A. Calculate the deflection at P, and Q. Also find the slope at A. Take the value of EI = 8400 Nm^2. **6**

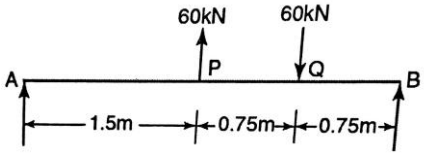


Fig Q1A

1B. A beam of L section is shown in fig Q 1B. If a moment of 3.4 kNm is applied about the horizontal neutral axis, inducing tension below the neutral axis, find the stresses at the extreme fibers of the cross section **4**

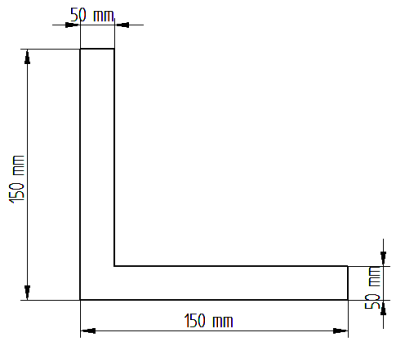


Fig Q.1B

2A. A hollow shaft 2m long has outer and inner diameters of 200mm and 150 mm respectively. If the angle of twist must not exceed 0.5˚ in 2m length and maximum shearing stress is not to exceed 50N/mm^2, find the maximum **5**

power that can be transmitted at 200 RPM. Take modulus of rigidity of material as 84 kN/mm^2.

2B. A trolley runs on 4 wheels mounted on 2 axles with a maximum load of 20000 kg as shown in Fig 2B. The trolley is attached to each axle through 2 bearings. The distance of wheels on axles is 800 mm, distance between bearings is 600 mm and is symmetrically located. Design a hollow axle considering bending (no transfer of torque) taking d_1/d_2 = 0.5 and allowable stress as 60MPa. **5**

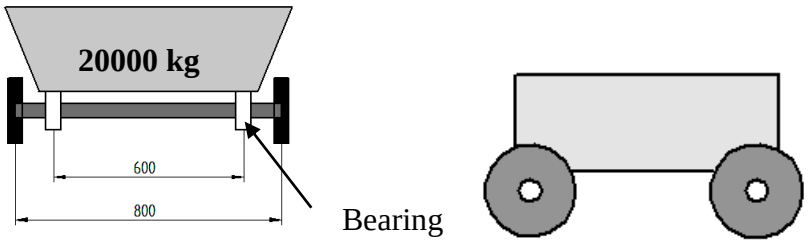


Fig Q.2B

3A. An element in a stressed material has a tensile stress of 500 MN/m^2 and a compressive stress of 350 MN/m^2 acting on 2 mutually perpendicular planes and equal shear stresses of 100 MN/m^2 on these planes. Find the principal stresses, position of principal planes, maximum shearing stress and position of plane of maximum shear stress. **4**

3B. A steel rod (Yield strength = 310 MPa) of 80mm diameter is subjected to a bending moment of 3 KNm and torque T. Taking factor of safety as 2.5, find the maximum value of torque T that can be safely carried by rod according to maximum normal stress theory. **4**

3C. A steel shaft 35 mm in diameter and 1.2m long is held rigidly at one end and has a hand wheel of 500 mm diameter keyed to it at the other end as shown in Fig Q.3C. If modulus of rigidity of steel is 80 GPa, find the force applied along the tangent to the rim of the wheel that produces a torsional shear of 60 MPa in the steel shaft. **2**

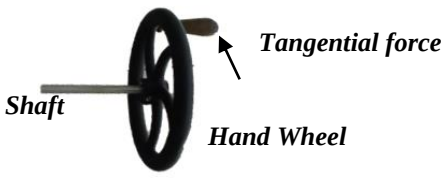


Fig Q3C

4A. A robot used to pick and place objects is shown in Fig Q.4A. The link 1 swivels about the axis A-A and the link 2 moves up and down to lift and drop the objects. Link 1 has a breadth of 50 mm and a depth of 30 mm. Link 2 has a square cross sectional of dimensions 10 mm X 10 mm. Both materials have a Young's modulus of 200 GN/m^2. If the link 2 is currently in the position shown in the figure, and is holding a load of 500 kg, what is the deflection of the tip. *(Consider the deflection of both the links).* **5**

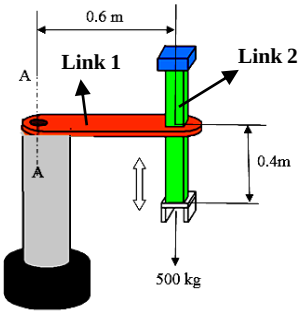
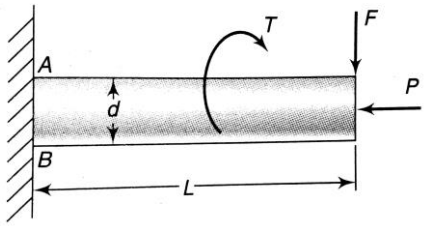


Fig Q. 4A

4B. A rectangular steel bar is 50 mm X 75 mm in cross section and 1m long. The yield point of the material used is 345 MN/m^2 and Young's modulus is 200 GPa. Assuming the steel bar to be hinged across both ends, calculate **5**

i. L/k ratio
ii. Check whether Euler's or Johnson's formula to be used
iii. Critical load

5A. A cantilever beam of circular cross section is loaded as shown in Fig Q.5A below. If the beam has a diameter of 40mm, select a suitable material from Table Q.5A. Use a factor of safety of 4. Adopt maximum shear stress theory. **5**



F= 450 N

P= 100 N

T= 62 Nm

L= 1m

Fig Q.5A

Material	Ultimate Strength (MN/m^2)	Yield strength (MN/m^2)
Wrought iron	332	186
Cast steel	414	218
SAE 1025 Annealed steel	462	234
SAE 1045 annealed steel	586	310
Water quenched steel	828	624
Oil quenched steel	952	700

Table Q.5A

5B. A shaft of 80 mm diameter and length 1 m is having a concentric bore of diameter 40mm as shown in Fig Q.5B. If the total twist is to be limited to 0.182˚, what should be the length of the bore? Draw a graph of length of bore versus total twist. Comment on the results. Take G=80 kN/mm^2. **5**

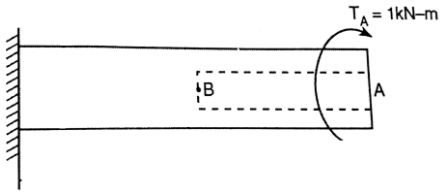


Fig Q.5B