Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: STRENGTH OF MATERIALS [MTE 2102]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. A bolt is subjected to a tensile load of 18KN and a shear load of 12KN. The material has a yield stress of 328.6MPa. Taking factor of safety as 2.5, determine the core diameter of bolt according to following theories of failure: **(06)**

(i). Maximum Normal stress theory

(ii) Maximum shear stress theory

(iv) Von Mises Theory

1B. A shaft is required to transmit 245kW power at 240 RPM. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed 40N/mm2 and twist 1 degree per meter length. Determine the diameter required if **(04)**

a. The shaft is solid

b. The shaft is hollow with external diameter twice the internal diameter. Take G=80kN/mm^2

2A. A 25 X 50mm bar of rectangular cross section of length 500mm is made of plain carbon steel (Yield strength = 380 N/mm^2 and E= 207000 N/mm^2). The 2 ends of the bar are hinged and the FOS is 2.5. The bar is subjected to an axial compressive force. **(04)**

a. Determine the slenderness ratio.

b. Which equation to use? Johnsons or Euler's?

c. What is the safe compressive force for the bar?

2B. A gantry robot (Cartesian coordinate robot) is as shown in figure Q2.B. A gripper travels on a linear guide to lift and drop weights. If the linear guide length is 2m, linear guide depth is 250mm and assuming a rectangular cross section, calculate the minimum guide breadth to be used if weight to be carried is 1500kg. The gripper itself weighs 100kg and the stress induced in the material should not exceed 20N/mm2. **(04)**

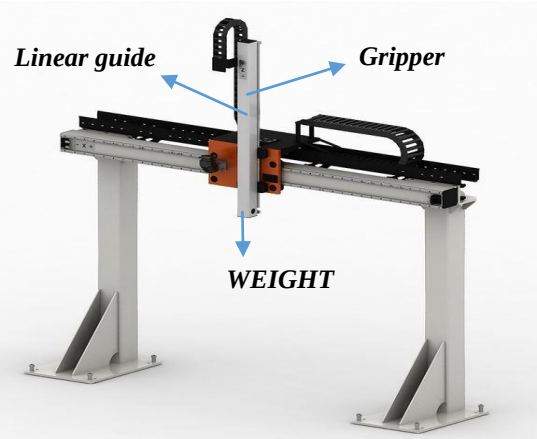

Fig Q2.B

2C. Show that the hollow circular shaft whose inner diameter is half the outer diameter has a torsional strength equal to 15/16 of that of a solid shaft of the same outside diameter. **(02)**

3A. A rotating shaft made of steel (Yield stress = 300N/mm^2) of 16mm diameter is subjected to an axial tensile load of 5000N, steady torque of 50Nm and maximum bending moment of 75Nm. Calculate the factor of safety based on maximum normal stress and maximum shear stress theories? **(05)**

3B. A stepped shaft is subjected to torque as shown in figure Q 3.B below. Determine the angle of twist at the free end. Take G=80KN/mm^2.Also find the maximum shear stress in any step. **(05)**

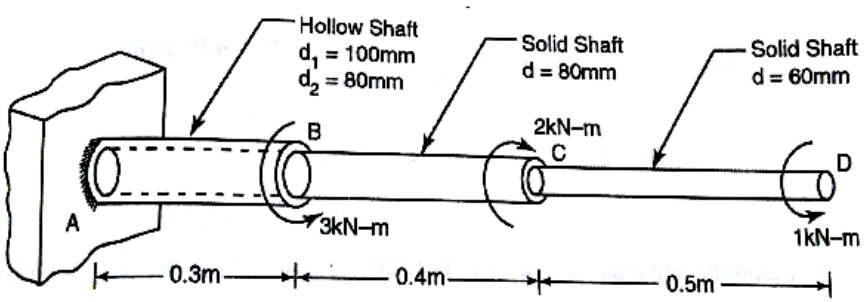

Fig Q3.B

4A. For the beam shown below in Fig Q4.A, calculate **(06)**

a. Deflection at C
b. Maximum deflection
c. Slope at end As

Take E=200GN/m^2 and I=20*$10^{-6}$$m^4$.

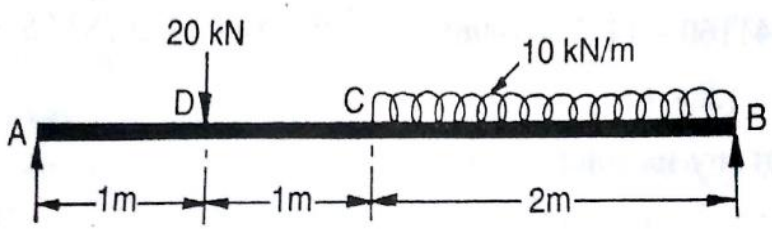

Fig Q4.A

4B. An element in a stressed material has a tensile stress of 500MN/m^2 and a compressive stress of 350MN/m^2 acting on 2 mutually perpendicular planes and equal shear stresses of 100mN/m^2 on these planes, Find the principal stresses, position of principal planes and maximum shearing stress. **(04)**

5A. The following figure (Fig Q5.A) shows a beam with I section. Find the position of neutral axis and the moment of inertia of the section about the neutral axis. Also determine the maximum bending moment that should be imposed on this section if tensile stress in the top- flange should not exceed 40MN/m^2 **(06)**

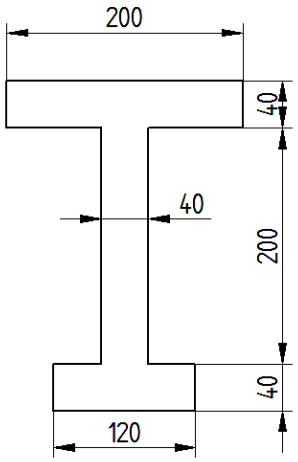

Fig Q5.A

5B. A rod of 50mm diameter is subjected to a load of F=2KN at the end of a lever 300mm long is fixed to the bar as shown in Fig Q5.B. Calculate the maximum and minimum principal stresses and maximum shear stress at **(04)**

a. Point E located at the top surface near fixed end
b. Point F located at bottom surface near fixed end.

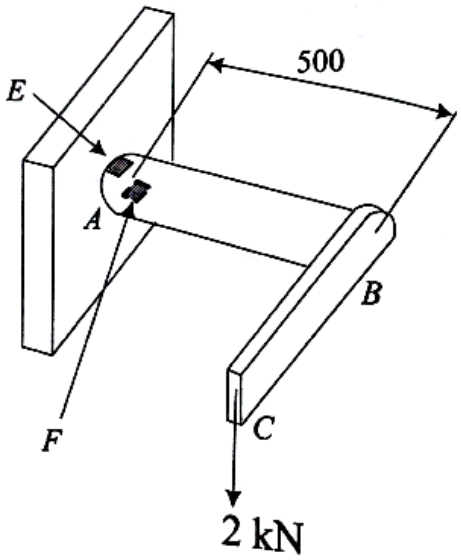

Fig Q5.B