# Question Paper

Exam Date & Time: 07-May-2018 (09:30 AM - 12:30 PM)

## MANIPAL ACADEMY OF HIGHER EDUCATION

**INTERNATIONAL CENTRE FOR APPLIED SCIENCES**
**END SEMESTER THEORY EXAMINATION - APRIL 2018**
**III SEMESTER B. S. (ENGG)**
**Date: 07.05.2018**
**Time: 9.30 A. M. TO 12.30 P.M.**
**DESIGN OF MACHINE ELEMENTS [ME 232]**

**Marks: 100** **Duration: 180 mins.**

**Answer 5 out of 8 questions.**

**Missing data, if any, may be suitably assumed.**
**Use of Design data hand book is permitted.**

1) A) A steel rod has the yield strength 350 N/mm$^2$ and the endurance limit of 265 N/mm$^2$ (complete stress reversal) subjected to an axial load which varies from - 300 kN minimum to 700 kN maximum and has a stress concentration factor of 1.8. Assuming the factor of safety 2, calculate the diameter of the rod. Ignore correction factors. (6)

B) Explain the steps involved in the designof an component of an assembly. (9)

C) A steel shaft of diameter20 mm and length 400 mm , as shown in figure Q1C is subjected to an axial load of 10 kN. Determine the following, (5)

i) Principle normal tensile stress
ii) Principle shear stress
iii) longitudinal strain

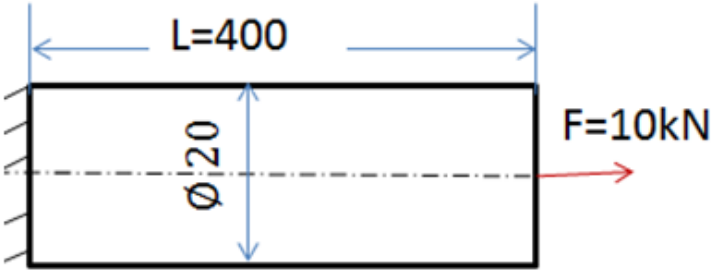


Figure Q 1C

2) A) What is meant by factor of safety? On what basis it is decided in the design of a component? (6)

B) A flat bar shown in figure Q2B is subjected to a tensile load of 10kN. (6)

Determine the thickness of flat if the maximum permissible stress is 80 MPa.

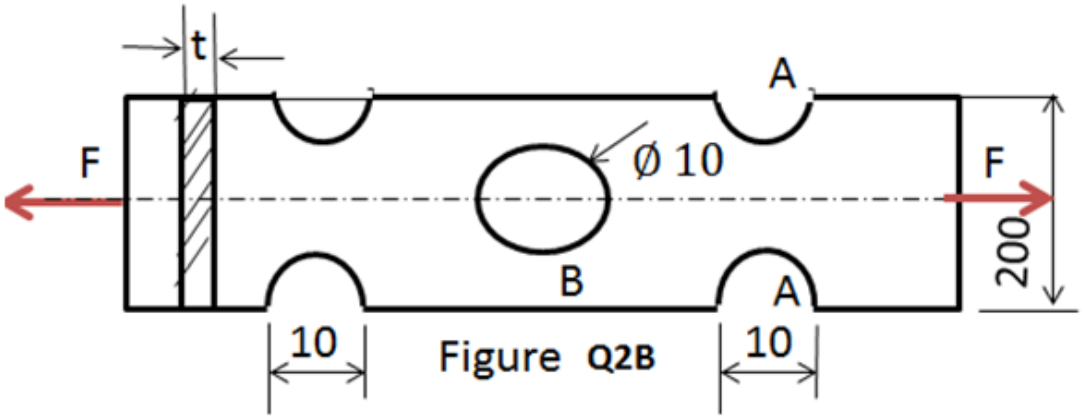

Figure Q2B

C) A steel rod of 50 mm diameter is subjected to an axial load of 20kN and a torsional moment of 1.5kN-m. The rod is made of C40 steel which has the yield strength of 328.6 MPa. Determine the factor of safety from the following theories of failure. Poisson's ratio $\mu$ = 0.3. (8)

i) Maximum principle stress theory
ii) Maximum shear stress theory
iii) Maximum normal strain theory
iv) Maximum distortion energy theory.

3) Prove that hollow shaft is stronger and stiffer than solid shaft for same length , weight and material. (10)

A)

B) A hollow shaft is supported in bearings 6m apart. The outer and inner diameters are 150 and 90 mms respectively. It is driven by a flexible coupling at one end and drives a propeller at the other end , at the speed of 180 rpm. When the shaft is transmitting 140kW, the maximum thrust on the propeller is 20KN. Shaft weighs 1000N. Yield strength of the shaft material is 240MPa. Find the maximum shear stress in the shaft. (10)

4) Design a spline which is required in an automotive vehicle gear box to transmit 45 kW at 1200 rpm. The shaft is made of SAE 1045annealed oil quenched steel. The factor of safety is 2.4 and stress concentration factor is 1.5. The yield strength in shear for SAE 1045 steel is240 MPa. Take coefficient of friction m=0.15. Design for 6 splines of C type for which the bearing pressure p = 7MPa. The spline parameters are as follows, (8)
Width b = 0.25D ; Height h=0.1D ; Length l = 1.5D where D is the major diameter of spline.

A)

B) The inner diameter of a cylindrical pressure vessel is 500mm and subjected to internal pressure of 2MPa. The cylinder cover is fixed to the cylinder body by means of 16 bolts of M20 size. Each bolt is initially tightened with a preload of 20kN.The yield strength of the bolt material is 320 MPa. Soft packing through bolts is used for fixing the cover to the cylinder. Determine the factor of safety for the bolts. (8)

C) A bolt is subjected to axial shock load so that the maximum applied load is 10000N. Assuming an allowable tensile stress of 50MPa , determine the size of the bolt. Neglect stress concentration. Ignore initial tightening load. (4)
It is desired to increase the shock absorbing capacity of the bolt. Determine the diameter of the hole to be drilled in the bolt to make it a bolt of uniform strength.

5) A) A screw jack is designed to carry a load of 20kN. The nominal diameter and pitch of the screw are 40 mm and 6 mm respectively. The coefficient of friction f between screw and nut is 0.15. The load is placed on a swivel cup which has annular bearing area with 45mm inner diameter and 70 mm as outer diameter. The coefficient of friction between cup and spindle head is 0.08. Hence the load does not rotate with the screw. Determine the torque required to lift the load and the efficiency of screw jack. (10)

B) Explain the following terms used in the design of helical springs (10)
i) Spring stiffness
ii) Spring index
iii) Free length,
iv) Operating length
v) Solid length

6) A) A load of 1000 N is suddenly dropped axially on a vertical closed coiled helical spring from a height of 250 mm. The wire diameter is 20 mm , spring index 8 and the spring has 20 active coils. Determine the deflection and the stress induced in the spring. (8)

B) An electric motor running at 1500 rpm is transmitting 15 kW power to a low speed shaft with a velocity ratio 3. The teeth are $14.5^0$ involute, with 25 teeth on the pinion. Both pinion and gear are made of steel, with static strength of 200 MPa. Assuming starting torque to be 25% higher than the running torque, determine the face width of the gears, from the strength point of view and also determine the principle dimensions of the drive. (12)

7) A) For a spur gear of 24 teeth with involute profile, module 5 mm and pressure angle $14.5^0$ calculate the following. (8)
i) Pitch circle diameter,
ii) Base circle diameter
iii) Addendum circle diameter
iv) Dedendum circle diameter
v) Clearance
vi) Circular pitch
vii) Addendum
viii) Dedendum

B) A bearing , 50 mm in diameter and 75 mm long supports a overhang shaft running at 900 RPM. The room temperature is $30^0$C (12)

and bearing temperature is $75^0$C. The viscosity of oil is 0.012 kg/m-s at the operating temperature of $120^0$C. The diametral clearance is 0.05 mm and the bearing is to operate in still air, without any artificial cooling. K = 300 W/$m^{20}$C. Determine

i) permissible load on the bearing and

ii) power loss.

8) A) A shaft rotating at 1440 rpm is supported by two bearings. The forces acting on each bearing are 6000 N radial and 3500 N axial thrust. The diameter of the shaft is 40 mm and the expected life of the bearing is 500 hrs. Check the suitability of SKF 6308 bearing for this condition. (10)

B) Distinguish between (10)

i) Static and dynamic load as applied to spur gear.

ii) Service factor and velocity factor as applied to gears.

iii) Hydrostatic and hydrodynamic bearing

iv) Pitch and lead of screw thread

v) Right hand and left hand thread

-----End-----