Question Paper

Exam Date & Time: 06-Jun-2019 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENES
IV SEMESTER B.Sc.(Applied Sciences) IN ENGINEERING END SEMESTER THEORY EXAMINATION-APRIL/MAY 2019

DESIGN OF MACHINE ELEMENTS [IME 242]

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

Answer ANY FIVE FULL questions.
Use of MACHINE DESIGN DATA HAND BOOK is permitted
Clearly mention the referred page/equation/table/figure number etc. for the data selected from Data Hand Book.
Additional data (if any) required may be suitably assumed.
Clearly mention the assumptions made (if any)

1) Explain the basic design procedure for a machine component with a flow chart. (5)

A)

B) A counter shaft running at 600 rpm is supported at bearings 600 mm apart. A pulley of 400 mm diameter is located 200 mm to the right of the right bearing and receives 30 kW power. The belt drive is at an angle of 60° above the horizontal to the left as seen from the left hand bearing. The pulley weighs 800N. Ratio of belt tensions is 2. Power is transmitted from the countershaft to a machine through a 200 mm diameter spur gear located 200 mm to the right of the left hand bearing. The gear has 20° involute tooth form and meshes with another gear located directly above the shaft; the direction of rotation is clockwise as seen from the left bearing. If the shaft is made of C45 steel, suggest suitable diameter for the shaft taking factor of safety as 2. Assume moderate combined shock and fatigue factor in bending and torsion. (15)

2) Differentiate between sliding contact and rolling contact bearings. (5)

A)

B) A shaft 65 mm diameter transmits power at maximum shear stress of 67 MPa. The shear stress in the key should not exceed 75 % of the shear stress developed in the shaft. Take the maximum crushing stress in the key as 2.5 times the maximum shear stress in the key. The dimension of the key is 18 mm x 11 mm. Determine the length of the key. (5)

C) A spur gear drive transmits 12 kW of power at 1500 rpm of pinion. The gear ratio is 4:1. The module is 4 mm. The pitch line velocity is 6.28 m/s. Both the gears are made of cast steel with a BHN value of 200.The gears are subjected to light shock with 8-10 hrs /day of service. The face width is 40 mm. Calculate the dynamic load and find the minimum necessary hardness. (10)

3) A) Define factor of safety (FOS). Briefly discuss the parameters which affect the magnitude of FOS in engineering design. (5)

B) A cover plate is bolted on to the flanged end of a pressure vessel through 6 bolts. The inner diameter of the pressure vessel is 200 mm and is subjected to an internal pressure of 11.5 MPa. Selecting C40 as the material for the bolts determine the size of the bolts, considering initial tension and hard copper gasket. Assume factor of safety = 2.5. (5)

C) A wall bracket is subjected to a load of 36 kN as shown in figure. Determine the permissible width and depth of the rectangular cross section, taking depth as thrice the width. Assume material as low carbon steel (Yield Strength σ_y = 328.6 MPa, Ultimate Strength σ_u = 472.5 MPa, Fracture Strength σ_f = 354.2 MPa) and a factor of safety of 2.5. Neglect the shear stresses due to bending if any. (All dimensions in mm). (10)

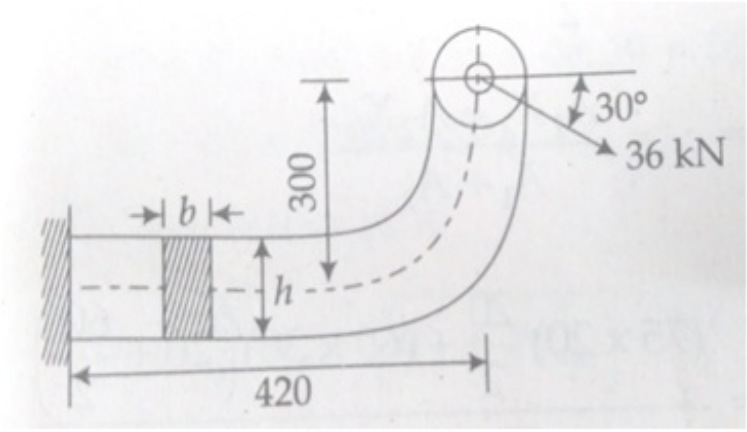


Figure 1

4) A) A SKF 6210 single row deep groove ball bearing operates at 1500 rpm and is acted upon by 8400 N radial and 2700 N thrust load. Inner row rotates with load being steady and continuous. Determine the rated life of the bearing. (10)

B) A 50 mm diameter shaft made of SAE grade steel (Yield strength σ_y = 525 MPa, ultimate strength σ_u = 700 MPa, Endurance limit σ_{en} = 350 MPa) and 600 mm span length is simply supported at the ends. It is subjected to fluctuating point load of W to 3W at the center. Determine the maximum cyclic load that can be applied to have an infinite life by using Soderberg's and Goodman's criteria. Assume factor of safety 1.3, a factor for fluctuating mean stress bending load as 0.95, size factor of 0.85 and surface finish factor of 0.9. (10)

5) A) Define fatigue. Draw a neat S-N diagram for steel material subjected to completely reversed bending stresses and mention all the salient features. (4)

B) A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. The coefficient of friction for the screw is 0.1 and for the collar is 0.09. Determine: (6)

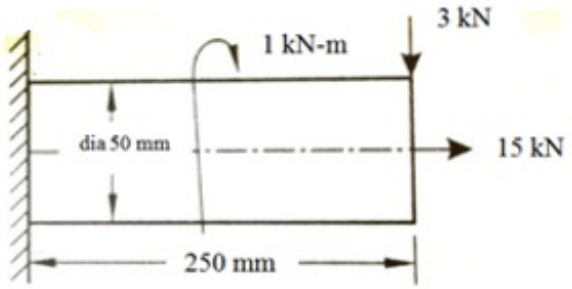
(i) Torque required to rotate the screw against the load (raising)
(ii) Is the screw self-locking?

C) Design a semi-elliptical leaf spring for a heavy duty railway wagon which exerts 7 x 10^4 N of load on spring. The length of the master leaf is 1160 mm between its supports. It is required to have stress equalized 18 leaves including 3 full lengths which are held rigidly by 160 mm wide central band. The material of the spring is high strength spring steel (E = 207 GPa, Elastic strength of 600 MPa, ultimate tensile strength of 1055 MPa, Fracture strength of 878 MPa). Assume the ratio of total spring depth to the width as 2. Take factor of safety as 1.5. Also determine, the net deflection in the spring due to applied load, the initial space provided for nipping and the load exerted on the central band after assembling. (10)

6) Define Creep. With the help of creep curve explain the phenomenon. (4)

A)

B) Determine the principal stresses and maximum shear stress for the component of diameter 50 mm subjected to system of loads as shown in figure. Neglect the shear stress developed due to bending. (6)

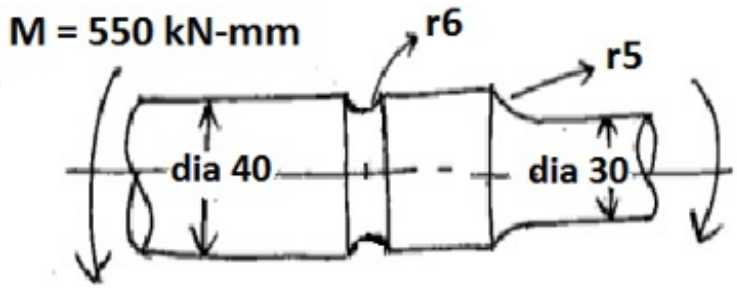


C) A helical gear drive with the pressure angle 20° transmits 44 kW of power at 6000 rpm of pinion. The helix angle is 20°. Speed ratio is 3:1. Gears are subjected to medium shock with 8-10 hours per day of service. Number of teeth on pinion are 20. Material for both pinion and gear is C30 steel. Design the gear with respect to strength by using Lewis method. (10)

7) A helical compression spring is to be designed for an operating load range of 1 kN to 1.3 kN. The initial compression of the spring is 60 mm for a load of 1 kN. Assume the spring index as 10.The shear stress in the spring material is 500 MPa and modulus of rigidity is 82.7 GPa. Design the spring. (8)

A)

B) A machine component is subjected to bending moment as shown in the figure (all dimensions in mm). (12)
i) Determine the location and magnitude of maximum stress.
ii) What material do you suggest for the machine component, if it is required to have FOS of 2 in static loading condition?
iii) If the bending moment is completely reversed cyclically, what would be the FOS in fatigue for the above selected material? Comment on the result.
(Assume notch sensitivity factor as 1, load factor as 1, size factor as 0.85 and surface finish factor as 0.8).



8) Differentiate between helical coil spring and leaf spring. (2)

A)

B) The lead screw of a lathe has single start ISO metric square threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of coefficient of friction at the screw threads and the collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rpm. Calculate the power required to drive the lead screw and efficiency of screw. (6)

C) It is required to design a solid shaft to receive 20 kW power through a horizontal belt drive and transmit to the flexible coupling just outside the right hand bearing at 150 rpm. The shaft is 2 m long between the bearings and carries a keyed pulley weighing 1200 N at the midpoint. The diameter of the pulley is 600 mm and the ratio of belt tension is 3:1. Assume $C_m = C_t = 1.5$. Determine the suitable shaft size as per ASTM standards. (12)

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