Reg. No. : | | | | | | | | | | |

Question Paper Code: 31573

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2016

Fifth Semester

Mechanical Engineering

01UME503 – DESIGN OF MACHINE ELEMENTS

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. What are the reasons for using different theories of failures?
2. What are preferred numbers?
3. Define critical speed of a shaft.
4. List the advantages of splines over keys.
5. What are the initial stresses induced due to screwing up forces?
6. Define the theory of bonded joints.
7. Why Wahl's factor is to be considered in the design of helical compression spring?
8. What are the stresses induced in flywheel arms?
9. Differentiate between full journal bearing and partial journal bearing.
10. List the significant factors to be considered for the formation of thick oil film in hydrodynamic bearing.

PART - B (5 x 16 = 80 Marks)

11. (a) A mild steel bracket as shown in figure 1, is subjected to a pull of 6000 *N* acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross-sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 *MPa*. (16)

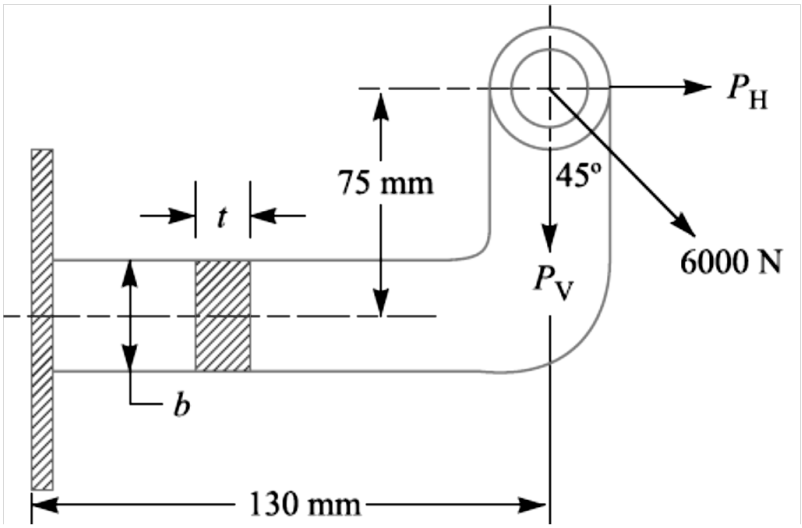


Figure 1

Or

(b) A circular bar of 500 *mm* length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 *kN* and a maximum value of 50 *kN*. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by: ultimate strength of 650 *MPa*, yield strength of 500 *MPa* and endurance strength of 350 *MPa*. (16)

12. (a) Design a cast iron protective type flange coupling to transmit 15 *kW* at 900 *rpm* from an electric motor to a compressor. The service factor may be assumed as 1.35. The following permissible stresses may be used:

Shear stress for shaft, bolt and key material = 40 *MPa*

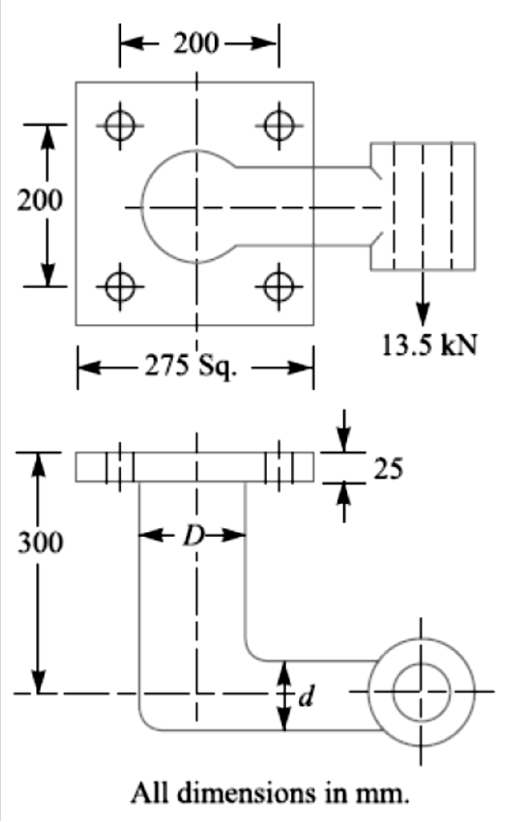
Crushing stress for bolt and key = 80 *MPa*

Shear stress for cast iron = 8 *MPa* (16)

Or

(b) A shaft carries a 1000 *N* pulley in the centre of two ball bearings which are 2000 *mm* apart. The pulley is keyed to the shaft and receives 30 *kW* of power at 150 *rpm*. The power is transmitted from the shaft through a flexible coupling just outside the right bearing. The belt derive is horizontal and the sum of the belt tension is 8000 *N*. Calculate the diameter of the shaft if permissible stress in bending is 80 N/mm^2 and in shear it is 45 N/mm^2. (16)

13. (a) The figure shows a solid forged bracket to carry a vertical load of 13.5 *kN* applied through the centre of the hole. The square flange is secured to the flat side of the vertical stanchion through four bolts. Calculate the suitable diameter '*D*' and '*d*' for the arms of the bracket, if the permissible stresses are 110 *MPa* in tension and 65 *MPa* in shear. Estimate also the tensile load on each top bolt and the maximum shear force on each bolt. (16)



Or

(b) Design a knuckle joint for a tie rod of a circular section to sustain a maximum pull of 70 *kN*. The ultimate strength of the material of the rod against tearing is 420 N/mm^2. The ultimate tensile and shearing strength of the pin material are 510 N/mm^2 and 396 N/mm^2 respectively. Determine the tie rod section and pin section. Take factor of safety as 6. (16)

14. (a) Design a close coiled helical compression spring for a service load ranging from 2250 *N* to 2750 *N*. The axial deflection of the spring for the load range is 6 *mm*. Assume a spring index of 5. The permissible shear stress intensity is 420 *MPa* and modulus of rigidity, $G = 84\ kN/mm^2$. Neglect the effect of stress concentration. Draw a fully dimensioned sketch of the spring, showing details of the finish of the end coils. (16)

Or

(b) The areas of the turning moment diagram for one revolution of a multi-cylinder engine with reference to the mean turning moment, below and above the line, are – 32, + 408, – 267, + 333, – 310, + 226, – 374, + 260 and – 244 mm^2.

The scale for abscissa and ordinate are: 1 *mm* = 2.4° and 1 *mm* = 650 *N-m* respectively. The mean speed is 300 *rpm* with a percentage speed fluctuation of ± 1.5%. If the hoop stress in the material of the rim is not to exceed 5.6 *MPa*, determine the suitable diameter and cross-section for the flywheel, assuming that the width is equal to 4 times the thickness. The density of the material may be taken as 7200 kg/m^3. Neglect the effect of the boss and arms (16)

15. (a) Design a journal bearing for a centrifugal pump from the following data:

Load on the journal = 20,000 *N*

Speed of the journal = 900 *rpm*.

Type of oil is SAE 10, for which the absolute viscosity at 55°*C* = 0.017 *kg / m-s*

Ambient temperature of oil = 15.5°*C*

Maximum bearing pressure for the pump = 1.5 N / mm^2

Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10°*C*.

Heat dissipation coefficient = 1232$W/m^2/°C$. (16)

Or

(b) Select a single row deep groove ball bearing for a radial load of 4000 *N* and an axial load of 5000 *N*, operating at a speed of 1600 *rpm* for an average life of 5 years at 10 hours per day. Assume uniform and steady load. (16)

———————