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Question Paper Code : P 1417

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fifth Semester

Mechanical Engineering

ME 1302 — DESIGN OF MACHINE ELEMENTS

(Common to B.E. (Part-Time) Fourth Semester — Regulation 2005)

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

Use of approved design data book is permitted.

Assumptions and assumed data have to be stated clearly.

PART A — (10 × 2 = 20 marks)

1. Define resilience.

2. What is Gerber theory?

3. Why is maximum shear stress theory used for shaft?

4. In what situation is flexible coupling used?

5. What is a stud?

6. Write down the expression for strength of parallel fillet weld in terms of permissible shear stress, leg of weld and length of welded joint.

7. What are the different styles of end for helical compression spring?

8. What do you mean by leverage?

9. State the disadvantages of thrust ball bearing.

10. Define coefficient of fluctuation of energy.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Two rods, made of plain carbon steel 40C8($S_{yt} = 380\ N/mm^2$) are connected by means of a cotter joint. The diameter of each rod is 50 mm and the cotter is made from a steel plate of 15 mm thickness. Calculate the dimensions of the socket end making the following assumptions:

(1) The yield strength in compression is twice of the tensile yield strength; and

(2) The yield strength in shear is 50% of the tensile yield strength.

The factor of safety is 6. (10)

(ii) Explain in detail the maximum shear stress theory. (6)

Or

(b) (i) A rod of a linkage mechanism made of steel 40Crl($S_{ut} = 550\ N/mm^2$) is subjected to a completely reversed axial load of 100 kN. The rod is machined on lathe and the expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition. (10)

(ii) Explain Soderberg and Goodman lines in detail. (6)

12. (a) A solid shaft of diameter 'd' is used in power transmission. Due to modification of existing transmission system, it is required to replace the solid shaft by a hollow shaft of the same material and equally strong in torsion. Further, the weight of hollow shaft per meter length should be half of the solid shaft. Determine the outer diameter of hollow shaft in terms of d.

Or

(b) It is required to design a rigid type of flange coupling to connect two shafts. The input shaft transmits 37.5 kW power at 180 rpm to the output shaft through the coupling. The service factor for the application is 1.5, i.e. the design torque is 1.5 times of rated torque. Select suitable materials for various parts of the coupling, design the coupling and specify the dimensions of its components.

13. (a) Bolts are used to hold the cover plate on a pressure vessel, which is subjected to an internal pressure varying from zero to 2 MPa. The area over which the pressure acts may be taken to correspond to 400 mm diameter circle. The bolts are preloaded to the extent of 1.3 times the maximum force exerted by the fluid on the cover plate. The combined stiffness of the parts, held together by the bolt (including copper gasket), is four times the stiffness of the bolt. Following data is given for the bolts:

Ultimate tensile strength = 900 N/mm^2

Yield Strength = 700 N/mm^2

Endurance limit in bending = 300 N/mm^2

Fatigue stress concentration factor = 2.2

Factor of safety = 1.5

Number of bolts = 8

Determine the size of the bolts assuming fine thread.

Or

(b) Derive an expression to find out the maximum shear stress in transverse fillet weld.

14. (a) A helical compression spring is used to absorb the shock. The initial compression of the spring is 30 mm and it is further compressed by 50 mm while absorbing the shock. The spring is to absorb 250 J of energy during the process. The spring index can be taken as 6. The spring is made of patented and cold drawn steel wire with ultimate strength of 1500 N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire should be taken as 30% of the ultimate tensile strength. Design the spring and calculate:

(i) Wire diameter

(ii) Mean coil diameter

(iii) Number of active turns

(iv) Free length; and

(v) Pitch of the turns.

Or

(b) A right angled bell-crank lever is designed to raise a load of 5 kN at the short arm end. The lengths of short and long arms are 100 and 450 mm respectively. The lever and the pins are made of steel 30C8($S_{yt} = 400\ N/mm^2$) and the factor safety is 5. The permissible bearing pressure on the pin is 10 N/mm². The lever has a rectangular cross section and the ratio of width to thickness is 3: 1. The length to diameter ratio of fulcrum pin is 1.25:1. Calculate:

(i) The diameter and length of fulcrum pin;

(ii) The shear stress in the pin;

(iii) The dimensions of boss of the lever at the fulcrum; and

(iv) The dimensions of the cross section of the lever

Assume that the arm of bending moment on the lever extends up to the axis of fulcrum.

15. (a) (i) A ball bearing is operated on work cycle consisting of three parts- a radial load of 3000 N at 1440 rpm for one quarter cycle, a radial load of 5000 N at 720 rpm for one half cycle, and radial load of 2500 N at 1440 rpm for the remaining cycle. The expected life of bearing is 10,000 hr. Calculate the dynamic load carrying capacity of the bearing. (10)

(ii) Explain in detail rolling contact bearing failure — causes and remedies. (6)

Or

(b) (i) The turning moment diagram of a multi cylinder engine is drawn with a scale of (1mm – 1°) on the abscissa and (1 mm = 250 N-m) on the ordinate. The intercepted areas between the torque developed by the engine and the mean resisting torque of the machine, taken in order from one end are – 350 + 800 – 600 + 900 – 550 + 450 and – 650 mm². The engine is running at a mean speed of 750 rpm and the coefficient of speed fluctuations is limited to 0.02. A rimmed flywheel made of grey cast iron FG200($\rho = 7100 kg/m^3$) is provided. The spokes, hub and shaft are assumed to contribute 10% of the required moment of inertia. The rim has rectangular cross section and the ratio of width to thickness is 1.5. Determine the dimensions of rim. (10)

(ii) List the types of lubrication used in journal bearings and their characteristics. (6)
