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Question Paper Code : 91845

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019
Fourth/Fifth/Sixth Semester
Mechanical Engineering
ME 6503 – DESIGN OF MACHINE ELEMENTS
(Common to Mechanical Engineering (Sandwich)/Automobile Engineering/ Industrial Engineering/Mechanical and Automation Engineering/Mechatronics Engineering)
(Regulations 2013)
(Also common to PTME 6503 – Design of Machine Elements for BE (Part-Time) Fourth Semester – Mechanical Engineering – Regulations 2014)

Time : Three Hours | Maximum : 100 Marks

Use of approved Design Data Book is permitted.
Any required design data can be suitably assumed.
Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Which theory of failure is suitable for the design of brittle materials ?
2. What are the common materials used in mechanical engineering design ?
3. What is the effect of key ways cut into the shaft ?
4. Differentiate between rigid coupling and flexible coupling.
5. Define equivalent torsional moment of a shaft.
6. Why throat portion is considered while calculating stresses in fillet welds ?
7. State any two functions of springs.
8. How does the function of flywheel differ from that of governor ?
9. Brief why fly wheels are used in punching machines.
10. What type of bearings can take axial load ?

PART – B (5×13=65 Marks)

11. a) Design a rectangular key for the following application : 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 stress developed in the shaft. The key should be at least 2.5 times strong in crushing compared to shear failure of the key. **(13)**

(OR)

b) Design a muff coupling, which is used to connect two steel shafts transmitting 25 kW power at 360 rpm. The shafts and key are made of plain carbon steel 30C8 ($S_{yt} = S_{yc} = 400$ N/mm^2). The sleeve is made of grey cast, iron FG 200 ($S_{ut} = 200$ N/mm^2). The factor of safety for the shafts and key is 4. For sleeve, the factor of safety is 6, based on ultimate strength. **(13)**

12. a) The shaft of length 1m carrying two pulleys 1 and 2 at its left and right ends respectively and it is supported on two bearings A and B which are located 0.25 m from the left end and the same 0.25 m from the right end respectively. The shaft transmits 7.5 kW power at 360 rpm from pulley 1 to pulley 2. The diameters of pulley 1 and 2 are 250 and 500 mm respectively. The masses of pulley 1 and 2 are 10 kg and 30 kg respectively. The belt tension act vertically downward and ratio of belt tensions on tight side to slack side for each pulley is 2.5:1. The yield strength of the shaft material $\sigma_y = 380$ MPa and factor of safety is 3. Estimate the suitable diameter of the shaft. **(13)**

(OR)

b) Design a bushed pin type of flexible coupling for connecting a motor and a pump shaft. The following data are provided :
Power transmitted = 20 kW; Speed = 1000 rpm; Diameter of the motor and pump shafts = 50 mm; Allowable bearing pressure in the rubber bush 0.3 MPa. **(13)**

13. a) A 600 mm diameter pulley driven by a horizontal belt transmits power through a solid shaft to a 262 mm diameter pinion which drives a matting gear. The pulley weighs 1200 N to provide some flywheel effect. The arrangement of elements, the belt tensions and components of the gear reactions on the pinion are as indicated in Figure 13(a). Determine the necessary shaft diameter using a suitable value for commercial shafting and shock fatigue factor of $K_b = 2$ and $K_t = 1.5$. **(13)**

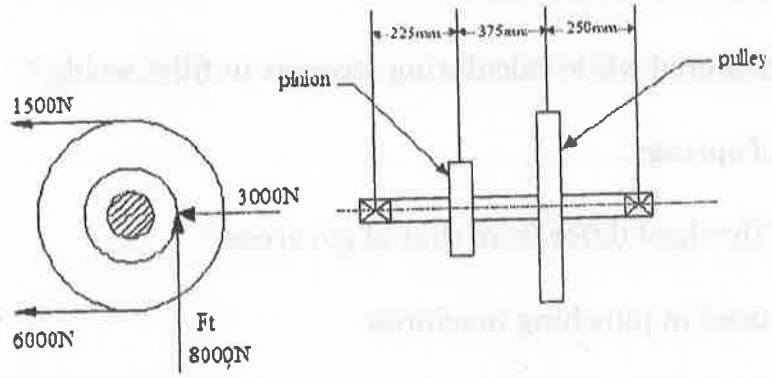

Fig. 13 (a)

(OR)

b) A shaft made of AISI 1030 cold drawn steel (σ_u= 520 MPa and σ_y = 440 MPa) transmits 50 kW at 900 rpm through a gear. Select an appropriate square key for the gear. **(13)**

14. a) 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 r.p.m. 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 to be 7200 kg/m^3. Neglect the effect of the boss and arms. **(13)**

(OR)

b) Design a leaf spring for the following specifications :

Total load = 140 kN ; Number of springs supporting the load = 4; Maximum number of leaves = 10 ; Span of the spring = 1000 nn; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm^2 and allowable stress in spring material as 600 MPa. **(13)**

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 r.p.m. ; Type of oil is SAE 10, for which the absolute viscosity at 55° C is 0.017 kg/m-s ; Ambient temperature of oil = 15.5° C ; Maximum bearing pressure for the pump = 1.5 N/mm^2. Take the diameter of the journal as 100 mm and length to diameter ratio as 1.6. 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 $W/m^2/°C$. **(13)**

(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 r.p.m. for an average life of 5 years at 10 hours per day. Assume uniform and steady load. Take 300 working days per year. **(13)**

PART – C (1×15=15 Marks)

16. a) A machine component subjected to a flexural stress which fluctuates is between + 300 MN/m^2 and – 150 MN/m^2. Determine the value of minimum ultimate strength according to

1) Garber relation
2) Modified Goodman relation and
3) Soderberg relation

Take yield strength = 0.55 Ultimate strength ;

Endurance strength = 0.5 Ultimate strength and factor of safety = 2. **(15)**

(OR)

b) It is required to design a knuckle joint to connect two circular rods subjected to an axial tensile force of 30 kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its components. Select suitable materials for the parts. Assume rod materials as 30 C8 and FOS = 5. **(15)**