CBCS SCHEME

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18ME62

# Sixth Semester B.E. Degree Examination, June/July 2024
## Design of Machine Elements – II

Time: 3 hrs. Max. Marks: 100

***Note:*** **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
**2.** ***Use of design data book is permitted.***



### Module-1

1 a. Briefly explain the construction and applications of Timing belts. **(06 Marks)**

b. Design a helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the above load range is 6 mm. Taking the spring index as 5 design the spring for a permissible stress of 420 MPa. Assume modulus of rigidity $G = 84\ kN/m^2$. **(14 Marks)**

**OR**

2 a. Explain the process of equalization of stresses in leaf springs. **(04 Marks)**

b. A pulley 200 mm diameter rotating at 900 rpm, has 6 grooves and drives another pulley of 500 mm diameter by means of V-belts of cross section C. The centre distance between pulleys is 1500 mm. The drive has to work for 12 hours/day under medium shock load. Find the power capacity of the drive. **(16 Marks)**

### Module-2

3 a. Derive an expression for formative number of teeth of a helical gear. **(06 Marks)**

b. Design a spur gear drive of steel to transmit 5 kW at 900 rpm. Allowable static stress for the material of the pinion is $\sigma_{d_1} = 200$ MPa and that of the gear is $\sigma_{d_2} = 140$ MPa. Diameter of the pinion is to be 100 mm. The centre distance of the drive is around 200 mm. The gear teeth are 20° FDI form. Service factor is to be 1.0. Determine the module and face width of the gears from the stand point of strength (Lewis equation). Check the design of gears for dynamic and wear strength. Assume class I, commercial gears for which consider dynamic load factor c = 572 N/mm. **(14 Marks)**

**OR**

4 a. Derive Lewi's equation for a spur gear. **(06 Marks)**

b. Design a pair of steel helical gears to transmit 18 kW from pinion rotating at 4000 rpm. The gear is to rotate at 800 rpm. The helix angle is 30°. The teeth are of 20° stub involute in diametral plane. Number of teeth on pinion is 20. Allowable static stress for material of pinion and gear is 51.7 MPa. Design the gear from the stand point of strength. Check the design for dynamic and wear strength. Take $C_S = 1.5$. Take dynamic load factor as C = 240 N/mm. **(14 Marks)**

### Module-3

5 A pair of straight tooth bevel gears at right angles is to transmit 5 kW at 1200 rpm of pinion. Pinion diameter is 80 mm and the velocity ratio is 3.5:1. The tooth form is $14\frac{1}{2}^\circ$ composite.

Both pinion and gear are of cast-iron with $\sigma_d = 55\ MN/m^2$.

(i) Determine the face width and the required module from the stand point of strength using Lewi's equation. Take $C_S = 1.0$.

(ii) Check the design for dynamic and wear strength. Take dynamic load factor C = 139.7 N/mm. **(20 Marks)**

**OR**

6 Design a worm gear drive to transmit 18 kW from a worm rotating at 1440 rpm to a worm wheel to rotate at 40 rpm. Assume 20° FDI form, service factor CS = 1.5. Worm is made of hardened steel while gear is of phosphor Bronze material with an allowable static stress of 103.5 MPa. Gear temperature is 60°C and ambient temperature is 30°C. Check the heating capacity of the drive and also calculate the efficiency of the worm gear drive. **(20 Marks)**

## Module-4

7 a. Derive an expression for torque transmission capacity of a cone clutch according to uniform wear theory. **(10 Marks)**

b. A multiple plate clutch has 2 bronze and 3 steel discs. The friction material can withstand a pressure of 0.1 N/mm$^2$ and coefficient of friction = 0.15. The outside and inside diameters of friction lining are 200 mm and 120 mm respectively. Determine the power transmitted by the clutch at 1000 rpm. **(10 Marks)**

**OR**

8 A single block brake with a torque capacity of 250 N-m is shown in Fig.Q8. The brake drum rotates at 100 rpm. Coefficient of friction is 0.35. Calculate:

(i) Actuating force and hinge pin reactions for clockwise rotation of the drum.
(ii) Actuating force for counterclockwise rotation of the drum.
(iii) The rate of heat generated during braking action.
(iv) Dimensions of shoe block if the allowable bearing pressure is 1 N/mm$^2$. The length of the block is twice its width.

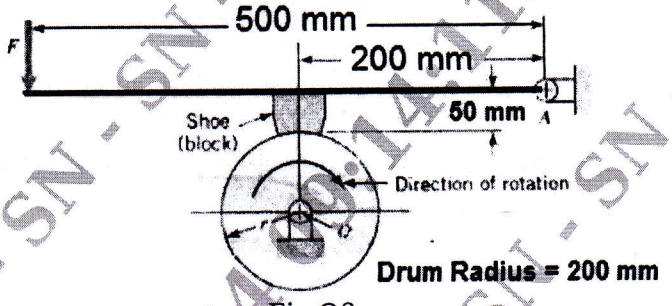


Fig.Q8 **(20 Marks)**

## Module-5

9 a. Mention the advantages and disadvantages of rolling contact bearings. **(06 Marks)**

b. A 75 mm long full journal bearing of diameter 75 mm supports a radial load of 12 kN at the shaft speed of 1800 rpm. Assume ratio of diameter to the diametral clearance as 1000. The viscosity of oil is 0.01 Pa.S at the operating temperature. Determine the following:

(i) Sommerfeld number
(ii) Coefficient of friction based on McKee's equation
(iii) Amount of heat generated **(14 Marks)**

**OR**

10 a. Derive an expression for coefficient of friction in a hydrodynamic bearing based on Petroff's equation. **(08 Marks)**

b. A ball bearing running at 900 rpm is subjected to a radial load of 2 kN and a thrust load of 1.2 kN. The bearing is in use for 10 hours per day, 6 days in a week for 3 years at 95% reliability. Determine the size of medium series ball bearing that can be used for the above loading condition. **(12 Marks)**

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