

Reg. No. :

**Question Paper Code : 53682**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fifth Semester

Robotics and Automation Engineering

RO 6503 — MECHANICAL DESIGN

(Regulation 2013)

Time : Three hours

Maximum : 100 marks

(PSG Design Data book brought by the candidate should be permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Herringbone gear? Where it is used?
2. Define the following terms :
  - (a) Tip circle
  - (b) Module
  - (c) Pitch circle.
3. List any four requirements of a good shaft coupling.
4. Explain the different types of failure of a rectangular key.
5. Sketch the cross section of the V belt and label its important parts.
6. Draw the construction of roller chain and mention their parts.
7. Define static and dynamic load carrying capacity of the bearing.
8. How to express the life of the bearing? What is  $B_{10}$  life of the bearing?
9. What are the functions of clutch?
10. What is positive clutches? List any two positive clutches.

PART B -- (5 × 13 = 65 marks)

11. (a) In a pair of spur gears, the number of teeth on the pinion and the gear are 20 and 100 respectively. The module is 6 mm. The pressure angle is  $20^\circ$  full depth. Calculate center distance pitch circle diameters of the pinion and the gear, Addendum and Dedendum, Tooth thickness, Bottom clearance and Gear ratio.

Or

- (b) A pair of parallel helical gears consists of a 23 teeth pinion meshing with a 46 teeth gear. The helix angle is  $24^\circ$  and the normal pressure angle  $21^\circ$ . The normal module is 4 mm. Calculate: (i) the transverse module (ii) the transverse pressure angle (iii) the axial pitch (iv) the pitch circle diameters of the pinion and the gear (v) the center distance and (vi) the addendum and dedendum circle diameters of the pinion.
12. (a) Design a protective type of cast iron flange coupling for a steel shaft transmitting 15 kW at 200 r.p.m. and having an allowable shear stress of 40 MPa. The working stress in the bolts should not exceed 30 MPa. Assume that the same material is used for shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14 MPa.

Or

- (b) The armature shaft of a 40 kW 720 rpm electric motor, mounted on two bearings A and B is shown in Figure 1. The total magnetic pull on the armature is 7 kN and it can be assumed to be uniformly distributed over a length of 700 mm midway between the bearings. The shaft is made of steel with an allowable shear stress of  $103.95 \text{ N/mm}^2$ . Determine the shaft diameter using the ASME code if  $k_m = 1.5$  and  $k_t = 1.0$ . Assume that the pulley is keyed to the shaft. The dimensions given in the diagram are in mm.

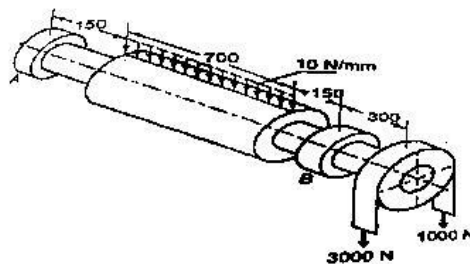


Figure 1

13. (a) A centrifugal pump running at 340 r.p.m is to be driven by a 100 kW motor running at 1440 r.p.m. The drive is to work for at least 20 hours every day. The center distance between the motor shaft and the pump shaft is 1200 mm. Suggest a suitable multiple V-belt drive for this application.

Or

- (b) A 10 kW, 1440 rpm motor drives a line shaft at 300 rpm by a chain drive. The center to center distance of the shaft is to be approximately 0.5 m. The motor shaft diameter is 40 mm. The starting torque of the motor is 2.5 times the running torque. The load is applied is with moderate shock. Select suitable roller chain drive.
14. (a) Select a bearing for a 40 mm diameter shaft rotates at 400 r.p.m. Due to a bevel gear mounted on the shaft, the bearing will have to with stand a 5000 N radial load and a 3000 N thrust load. The life of the bearing expected to be at least 1000 hrs. Assume there is no impact load on the machine. And also draw the cross section of the ball bearing.

Or

- (b) A transmission shaft rotating at 720 rpm and transmitting power from the pulley P to the spur gear G shown in figure 2. The belt tensions and the gear tooth forces are as follows:  $P_1 = 498$  N,  $P_2 = 166$  N, and  $P_t = 497$  N,  $P_r = 181$  N. The weight of the pulley is 100 N. The diameter of the shaft at bearings  $B_1$  and bearing  $B_2$  is 10 mm and 20 mm respectively. The load factor is 2.5 and the expected life for 90% of the bearings is 8000 hrs. Select single row deep groove ball bearings at  $B_1$  and  $B_2$ .

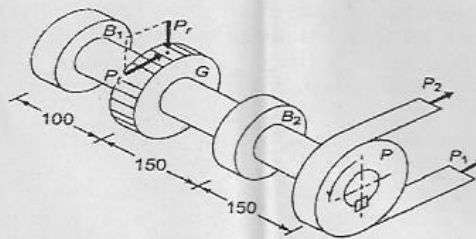


Figure 2



15. (a) A friction clutch is used to rotate a machine from a shaft rotating at a uniform speed of 250 r.p.m. The disc type clutch has both of its sides effective, the coefficient of friction being 0.3. The outer and inner diameters of the friction plate are 200 mm and 120 mm respectively. Assuming uniform wear of the clutch, the intensity of the pressure is not to exceed  $100 \text{ kN/m}^2$ . If the moment of inertia of the rotating parts of the machine is  $6.5 \text{ kg-m}^2$ .
- Determine the time to attain the full speed by the machine and the energy lost in the slipping of the clutch.
  - What will be the intensity of pressure, if the condition of uniform pressure of the clutch is considered?
  - Determine the ratio of power transmitted with uniform wear to that with uniform pressure.

Or

- (b) Derive a torque transmitted by a single plate clutch and also derive the expression for mean radius of the clutch by using uniform pressure and wear theory.

PART C — ( $1 \times 15 = 15$  marks)

16. (a) A belt pulley is connected to a 30 mm diameter shaft by means of a flat sunk key. The width and the length of the key are 8 and 45 mm, respectively. The shaft rotates at 300 rpm. The key is made of commercial steel with ultimate tensile strength of  $600 \text{ N/mm}^2$  as per Indian standard. Assume and,

$$\begin{aligned} S_{uc} &= 1.25 S_{ut} \\ S_{sc} &= 0.5 S_{ut} \end{aligned}$$

The factor of safety is 5. Determine

- Power transmitting capacity of the key based on shear criterion and
- For this power, determine the height of the key based on compression criterion.

Or

- (b) A cast steel 24 teeth spur pinion operating at 1150 rpm transmits 3 kW to a cast steel spur wheel. The gear ratio is 2.25. The tooth profile is  $20^\circ$  full depth involute. Design the gears and check for stresses.