

Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 7 –
EXAMINATION – SUMMER 2026

Subject Code: 3171917

Date: 03/06/2026

Subject Name: Design of Machine Elements

Time: 02:30 PM TO 05:30 PM

Total Marks: 70

Instructions:

- 1. Attempt all questions.**
- 2. Make suitable assumptions wherever necessary.**
- 3. Figures to the right indicate full marks.**
- 4. Simple and non-programmable scientific calculators are allowed.**
- 5 . PSG design data book and V B Bhandari data book are permitted."**

Q.1

- (a) What is tolerance? Explain various terms used in specifying the tolerance for a given dimension. 03**
- (b) The tolerances for a shaft and bearing are H8/g7. If the nominal size of the shaft is 50 mm, determine the limits of dimensions of shaft and bearing. What is the type of the fit? 04**
- (c) A pair of spur gears consists of a 24 teeth pinion, rotating at 1000 rpm and transmitting power to a 48 teeth gear. The module is 6 mm, while the face width is 60 mm. Both gears are made of steel with an ultimate tensile strength of 450 N/mm². They are heat treated to a surface hardness of 250 BHN. Assume that velocity factor accounts for the dynamic load. Calculate (i) beam strength; (ii) wear strength; and (iii) the rated power that the gears can transmit, if service factor and the factor of safety are 1.5 and 2, respectively. 07**

Q.2

- (a) Explain the different cross section being used for hook design. 03**
- (b) What is the curvature effect in a helical spring? How does it vary with spring index? 04**
- (c) Explain the design of Protected type Rigid Flange Coupling. 07**

OR

Q.2

- (c) Design a bushed pin-type flexible coupling for transmission of 30 kW from a motor to a centrifugal pump shaft, at 1,440 rpm. The following data is given: Diameter of motor shaft = 36 mm; Diameter of pump shaft = 30 mm; Allowable bearing pressure in rubber bush = 0.5 MPa; Allowable stress in pins = 50 MPa. **07**

Q.3

- (a) Explain the effect of nipping of leaves in carriage springs. **03**
- (b) What is Buckling of Compression Spring? Explain one method of avoiding the tendency of a compression spring to buckle. **04**
- (c) A helical compression spring is made of music wire. The spring has to support a load of 150 N. Due to space limitations, the outer diameter of the spring should not exceed 25 mm, the solid length should not to exceed 40 mm, and the free length of the spring is not to exceed 100 mm. Allowable shear stress for music wire is 800 MPa and $G = 81000 \text{ N/mm}^2$. **07**

OR

Q.3

- (a) Explain the causes of failure in pressure vessels? **03**
- (b) Derive and Explain the Clavarino's and Birnie's equations for Pressure vessels Design. **04**
- (c) A high pressure cylinder consists of an inner cylinder of inner and outer diameters of 200 and 300 mm respectively. It is jacketed by an outer cylinder with an outside diameter of 400 mm. The difference between the outer diameter of the inner cylinder and the inner diameter of the jacket before assembly is 0.25 mm ($E = 207 \text{ kN/mm}^2$). Calculate the shrinkage pressure and the maximum tensile stress induced in any of the cylinders **07**

Q.4

- (a) Derive the expression of Striebeck's Equation for Load distribution on balls in a Rolling Bearing. **03**
- (b) If the designation of a bearing is 6308, give its complete specification from the SKF catalogue and determine its life at 20,000 N dynamic load. If the bearing rotates at 720 rpm, what are its life in hours? **04**
- (c) On a hydro-static thrust bearing, the axial thrust load is 400 kN, while the shaft rotates at 800 rpm. If the diameter of the shaft is 400 mm and the diameter of the recess is 320 mm, film thickness is 0.10 mm, viscosity of lubricant is 150 SUS, and specific gravity is 0.86, calculate the supply pressure and flow requirements. **07**

OR

Q.4

- (a) Derive the expression of Lewis form factor in Gear design. how does it vary with number of teeth on gear? 03
- (b) Derive the expression for efficiency of worm wheel drive. 04
- (c) A pair of helical gears transmits 5 kW. The following are its details: Teeth on pinion, $Z_p = 25$; Teeth on gear, $Z_g = 50$; Normal module, $m_n = 4$ mm Helix angle $\Phi = 20^\circ$; Normal pressure angle, $\alpha_n = 20^\circ$. Determine P_t , P_a , and P_r components of tooth load and draw the force analysis diagram. The pinion runs at 1,200 rpm. 07

Q.5

- (a) Explain spiral bevel gears with Spiral Gear Terminology. 03
- (b) Fatigue life of a 6×37 wire rope of nominal diameter 12 mm is to be achieved to 2×10^5 bends. Tensile stress designation of wire is a 1960. How much load can be lifted through a sheave diameter 480 mm, through the arrangement shown in the Fig. 04



- (c) Design an exhaust valve for a horizontal diesel engine using the following data: Cylinder bore = 150 mm Length of stroke = 275 mm Engine speed = 500 rpm Maximum gas pressure = 3.5 MPa Seat angle = 45° Calculate: (i) diameter of the valve port; (ii) diameter of the valve head; (iii) thickness of the valve head; (iv) diameter of the valve stem; and (v) maximum lift of the valve. 07

OR

Q.5

- (a) Explain Constant Loss of Economic Cutting Speed and Constant Loss of Productivity in the Whole rpm Range of gear box design. 03
- (b) What are the fundamental principles or mechanical regulation? Describe the principle of stepped speed regulation as applied to machine tools. 04
- (c) Design a gear box of a machine tool (turret) having 9 spindle speeds ranging from 90 to 1800 rpm. The gear box should be a compact one. Also (a) Represent the speeds graphically. (b) Draw the structural diagram. (c) Show the layout of the gear box. (d) Find Out the numbers of teeth on various gears. 07
