

Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING – SEMESTER 7 – EXAMINATION – SUMMER 2026

Subject Code: 2171909

Date: 29/05/2026

Subject Name: Machine Design

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. Use of Design Data book is permitted.**

- Q.1**
- (a) Explain different types of gear tooth failures. **03**
 - (b) Explain interference and undercutting in involute gear tooth profile. **04**
 - (c) A pair of straight teeth spur gears, having 20° involute full depth teeth is to transmit 12 kW at 300 r.p.m. of the pinion. The speed ratio is 3 : 1. The allowable static stresses for gear of cast iron and pinion of steel are 60 MPa and 105 MPa respectively. Assume the following:
Number of teeth of pinion = 16; Face width = 14 times module; Velocity factor $C_v = 4.5/(4.5+v)$ v being the pitch line velocity in m / s; and tooth form factor $(y) = 0.154 - (0.912 / \text{No. of teeth})$. Determine the module, face width and pitch diameter of gears. Check the gears for wear; given $\sigma_{es} = 600$ MPa; $E_p = 200$ kN/mm² and $E_G = 100$ kN/mm². **07**
- Q.2**
- (a) What is Lewis form factor? How does it vary with number of teeth on gear? **03**
 - (b) List the major advantages of using geometric progression of for speed regulation in a gear box. **04**
 - (c) Explain the design procedure of helical gear based on beam strength and wear strength theory. **07**
- OR
- (c) What is range ratio in gear box design? Explain the procedure to construct speed diagram (ray diagram) for gear box. **07**
- Q.3**
- (a) Explain the classification of sliding contact bearings. **03**
 - (b) What are the advantages of hydrodynamic lubrication? **04**
 - (c) A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm². The speed of the journal is 900 r.p.m. and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C . Find :1. The amount of artificial cooling required, and 2. The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C . Take specific heat of the oil as 1850 J / kg / $^\circ\text{C}$. **07**

OR

Q.3

- (a) Define static and dynamic load carrying capacities of rolling contact bearings. **03**
- (b) Discuss advantages of rolling contact bearings over sliding contact bearings. **04**
- (c) A single row angular contact ball bearing number 310 is used for an axial flow compressor. The bearing is to carry a radial load of 2500 N and an axial or thrust load of 1500 N. Assuming light shock load, determine the rating life of the bearing. **07**

- Q.4**
- (a) What are the typical causes of failure in rolling contact bearings? **03**
 - (b) Give classification of cranes. **04**
 - (c) Classify material handling equipment. What are the basic objectives that a material handling equipment should fulfil? **07**

OR

- Q.4**
- (a) Explain the designation used for a steel wire rope. **03**
 - (b) Explain briefly about piston rings. **04**
 - (c) Determine the dimensions of cross-section of the connecting rod for a diesel engine with the following data: **07**
 Cylinder bore = 100 mm
 Length of connecting rod = 350 mm
 Maximum gas pressure = 4 MPa
 Factor of safety = 6

- Q.5**
- (a) Name the materials used for engine piston. **03**
 - (b) what is the function of connecting rod? what are the forces acting on the connecting rod? **04**
 - (c) The following data is given for the piston of a four-stroke diesel engine: **07**
 Cylinder bore = 250 mm
 Maximum gas pressure = 4 MPa
 Bearing pressure at small end of connecting rod = 15 MPa
 Length of piston pin in bush of small end = 0.45D
 Ratio of inner to outer diameter of piston pin = 0.6
 Mean diameter of piston boss = 1.4 * outer diameter of piston pin
 Allowable bending stress for piston pin = 84 N/mm²
 Calculate:
 (i) outer diameter of the piston pin;
 (ii) inner diameter of the piston pin;
 (iii) mean diameter of the piston boss; and
 (iv) check the design for bending stresses.

OR

- Q.5**
- (a) Give practical applications of wire rope. **03**
 - (b) Explain the design of hook in brief. **04**

- (c) A 6 * 19 wire rope with fibre core and tensile designation of 1570 is used to raise the load of 20 kN as shown in Figure. The nominal diameter of the wire rope is 12 mm and the sheave has 500 mm pitch diameter. Determine the expected life of the rope assuming 500 bends per week.


