

Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VII EXAMINATION – SUMMER 2025

Subject Code:2171909

Date:16-05-2025

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

	MARKS
Q.1 (a) How the failures occur in gear tooth?	03
(b) Briefly explain about the selection of gear materials.	04
(c) A spur gear drive is required to transmit a maximum power of 22.5 kW. The velocity ratio is 1:2 and r.p.m. of the pinion is 200. The approximate center distance between the shafts may be taken as 600 mm. The teeth has 20° stub involute profiles. The static stress for the gear material (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation or dynamic factor in the Buckingham equation may be taken as 80 and the material combination factor for the wear as 1.4.	07
Q.2 (a) Enlist the properties of journal bearing materials.	03
(b) Derive the equation for equivalent dynamic load for rolling contact bearing which are subjected to cyclic loads and speeds.	04
(c) Design a machine tool gear box with the output speeds are 1000 r.p.m. maximum and 160 r.p.m. minimum. The gear box is a six speed gear box having structural formula (a) 2(3) 3(1) (b) 2(1) 3(2). Draw speed diagram and layout for above gear box.	07

OR

- (c)** A pair of cast iron bevel gears connect two shafts at right angles. The pitch diameters of the pinion and gear are 80 mm and 100 mm respectively. The tooth profiles of the gears are of 14(1/2)° composite form. The allowable static stress for both the gears is 55 MPa. If the pinion transmits 2.75 kW at 1100 r.p.m., find the module and number of teeth on each gear from the

standpoint of strength and check the design from the standpoint of wear.

Take surface endurance limit as

630 MPa and modulus of elasticity for cast iron as 84 kN/mm².

- Q.3 (a)** Describe the relationship between L_{50} and L_{10} life of rolling contact bearing. **03**
- (b)** Enumerate the steps for selection of rolling contact bearings for a particular application. **04**
- (c)** Design a journal bearing for a centrifugal pump from the following data : **07**
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 = 0.017 kg/m-s; Ambient temperature of oil = 15.5°C; Maximum bearing pressure for the pump = 1.5 N/mm².
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/m²/°C.

OR

- Q.3 (a)** Enlist two applications each of hydrostatic and hydrodynamic journal bearing. **03**
- (b)** Explain in detail about the classification of journal bearings. **04**
- (c)** A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3 kN for 10 per cent of time, 2 kN for 20 per cent of time, 1 kN for 30 per cent of time and no load for remaining time of cycle. If the total life expected for the bearing is 20×10^6 revolutions at 95 per cent reliability, calculate dynamic load rating of the ball bearing. **07**
- Q.4 (a)** Explain briefly about piston rings. **03**
- (b)** Describe the steps for cylinder design of internal combustion engine. **04**
- (c)** Design a web (I-section), small and big end of the connecting rod for an I.C. engine running at 1800 r.p.m. and developing a maximum pressure of 3.15 N/mm². The diameter of the piston is 100 mm; mass of the reciprocating parts per cylinder 2.25 kg; length of connecting rod 380 mm; stroke of piston 190 mm and compression ratio 6: 1. Take a factor of safety of 6 for the design. Take length to diameter ratio for big end bearing as 1.3 and small end bearing as 2 and the corresponding bearing pressures as 10 N/mm² and 15 N/mm². The density of material of the rod may be taken as 8000 kg/m³ and the allowable stress in the bolts as 60 N/mm² and in cap as 80 N/mm². **07**

OR

- Q.4** (a) Why I section with width = $4t$ and height = $5t$ is preferred for the connecting rod, where t = web thickness? **03**
- (b) What are the methods and materials used in the manufacture of crankshafts? **04**
- (c) Determine the thickness of the piston crown and diameter of piston pin of a cast iron piston for a single acting four stroke engine using the following data: **07**
- Cylinder bore = 100 mm; Stroke = 125 mm; Maximum gas pressure = 5 N/mm²; Indicated mean effective pressure = 0.75 N/mm²; Mechanical efficiency = 80%; Fuel consumption = 0.15 kg per brake power per hour; Higher calorific value of fuel = 42×10^3 kJ/kg; Speed = 2000 r.p.m.
- Any other data required for the design may be assumed.
- Q.5** (a) Differentiate between thin and thick film lubrication in relation to journal bearing. **03**
- (b) Discuss in detail the various types of stresses a wire rope is subjected. **04**
- (c) Determine a crane hook thickness and crane shank width to lift a load of 75000 N. Take factor of safety as 4 for a high alloy steel of yield strength as 342 N/mm². Assume the hook inner radius as 380 mm. **07**

OR

- Q.5** (a) Enlist the assumptions taken while deriving Reynold's equation for hydrodynamic lubrication. **03**
- (b) Describe the advantages of a wire rope over fibre rope. **04**
- (c) A temporary construction elevator is designed to carry workers and materials to a height of 35 m. It is estimated that at least 10 workers with material load of 15 kN should be hoisted at a speed of 0.5 m/s which should be attained in the first 0.4 s. The recommended steel rope is 6×19 with wire diameter of 2.5 mm. Determine the factor of safety during normal working of elevator. **07**
