

GUJARAT TECHNOLOGICAL UNIVERSITY**BE – SEMESTER- VII EXAMINATION-SUMMER 2023****Subject Code: 2171909****Date: 26/06/2023****Subject Name: Machine Design****Time: 10:30 AM TO 01:30 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 pair of spur gears consist of pinion 30 teeth, running at 1000 rpm transmitting power to a 75 teeth gear. Module of gear tooth is 5 mm and face width is 60 mm. Both the gears are made of steel with $\sigma_{ut} = 450$ MPa. Gears are heat treated to a surface hardness of 350 BHN. Service factor is 1.5 and factor of safety is 2. Determine: (a) Beam strength (b) Wear strength of gear tooth (c) The amount of power that can be transmitted by gears. **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 50 HP power motor running at 750 rpm drives another shaft at right angle through 90° bevel gearing. The velocity ratio is 3:1. The pinion, mounted on the power motor is of 20° full depths involute. Design the bevel gear drive providing the minimum number of teeth on pinion to be 20. The material of pinion and gear are same and made of 55C8. The yield strength of 55C8 is 720 MPa. Assume factor of safety as 3 and velocity factor as 0.5. **07**
- 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 electric generator to carry a radial load of 3000 N. The journal having 50 mm diameter rotates at 1500 rpm. The viscosity of oil at the operating temperature is 25 cP. Assume $p_{\max} = 1.4 \text{ MN/m}^2$, $(ZN/p)_{\min} = 29.01$, $(c/r) = 0.0013$ and $(l/d) = 1.0$. **07**

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 radial ball bearing was selected for a machine shaft of diameter varying from 15 mm to 20 mm operating under radial load of 900 N, shaft speed 5000 rpm and for 3000 h life. After being used for 8 months, bearing was fitted in another machine for some urgent operation and production. The shaft will be subjected to the same radial load in addition to axial load of 500 N and operating at the same speed. Determine the expected median life for this operation. Would replacement by different bearing will provide a rated life of 3000 h? Give your suggestions. **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 a petrol engine from the following data: **07**
 - (i) Diameter of piston = 100 mm, (ii) Weight of reciprocating part = 1.8 kg, (iii) Length of connecting rod = 315 mm, (iv) Stroke = 140 mm, (v) Speed = in the range of 1500 to 2500 rpm, (vi) Compression ratio = 4:1, (vii) Maximum explosion pressure = 2.5 MPa.

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 for a four-stroke diesel engine developing power at 1500 rpm. Other related data are the following: **07**
- (i) Piston diameter = 87 mm, (ii) Length of the stroke = 96 mm, (iii) Mean effective pressure = 0.7 N/mm^2 , (iv) bsfc = 0.26 kg/kWh, (v) L/r ratio = 4, (vi) Heat conducted through the piston crown = 10% of heat generated during combustion, (vii) Calorific value of the fuel (CV) = 42 MJ/kg.

Assume that the piston is made of aluminium alloy.

- 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/mm^2 . 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**