

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VII (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2171909

Date: 09/05/2017

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.

- Q.1** (a) Explain in detail: (i) Law of gearing (ii) Gear tooth failures. **07**
(b) Classify the bearing and explain the properties of bearing lubricant. **07**

- Q.2** (a) A pair of bevel gear with 20° pressure angle consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4 mm, while the face width is 20 mm. The material for pinion and gear is steel 50C4 ($\sigma_{ut}=750 \text{ N/mm}^2$). The surface hardness of gear is 400 BHN. The pinion rotates at 500 rpm and receives 2.5 kW power from the electric motor. The service factor is 1.5. Determine the factor of safety against bending failure and against pitting failure. **07**
(b) Explain in detail the design procedure of sheave and drum with necessary equations. **07**

OR

- (b) A 17-tooth 20° pressure angle spur pinion rotates at 1800 rev/min and transmits 4 hp to a 52-tooth disk gear. The diametral pitch is 0.4 teeth/mm, the face width 38 mm, and the quality standard is No. 6. The gears are straddle-mounted with bearings immediately adjacent. The pinion is a grade-1 steel with a hardness of 240 Brinell tooth surface and through-hardened core. The gear is steel, through-hardened also, grade 1 material, with a Brinell hardness of 200, tooth surface and core. Poisson's ratio is 0.30, $J_P = 0.30$, $J_G = 0.40$, and Young's modulus is $208 \times 10^3 \text{ N/mm}^2$. The loading is smooth because of motor and load. Assume a pinion life of 10^8 cycles and a reliability of 0.90, and use load cycle factor $Y_N = 1.3558N^{-0.0178}$, $Z_N = 1.4488N^{-0.023}$. The tooth profile is uncrowned. This is a commercial enclosed gear unit. Consider following factors in the AGMA design of gear as per usual notations.
 $k_0=1$, $k_B=1$, $k_m=1.22$, $(k_s)_P = 1.043$, $(k_s)_G=1.052$, $k_T=1$, $k_R=0.85$, $(S_t)_P=31350$, $(S_t)_G= 28260$, $k_v=1.377$.
(a) Find the factor of safety of the gears in bending.
(b) Find the factor of safety of the gears in wear. **07**

- Q.3** (a) Explain: (i) Thermal rating of worm gearing (ii) Efficiency of worm gearing. **07**
(b) A worm drive transmits 15 kW at 2000 rpm to a machine carriage at 75 rpm. The worm is triple threaded and has 65 mm pitch diameter. The worm gear has 90 teeth of 6 mm module. The tooth form is to be 20° full depth involute. The coefficient of friction between the mating teeth may be taken as 0.10. Calculate:
1. Tangential force acting on the worm
2. Axial thrust and separating force on worm
3. Efficiency of the worm drive. **07**

OR

- Q.3** (a) Draw the ray and speed diagram for a nine speed gear box. State the necessary assumptions taken. **05**

- (b) A 2x2 drive is required to be designed for transmitting speeds starting from 400 rpm with a geometric progression of 1.4. Draw a suitable structure and speed diagram. Also draw the layout of the gearbox and determine the number of teeth on each gear. **09**
- Q.4 (a)** Explain the construction and working of valve gear mechanism with neat sketch. **05**
- (b)** The following data is given for a connecting rod having I-cross-section dimensions (4t x 5t): **09**
Engine speed = 1800 rpm, Length of connecting rod = 350 mm, Length of stroke = 175 mm, Density of material = 7800 kg/m³, Thickness of web or flanges (t) = 8 mm, Mass of reciprocating parts = 2.5 kg, Permissible tensile stress for bolts = 60 N/mm². Calculate: (i) Nominal diameter of bolts (ii) Whipping stress in the connecting rod.
- OR**
- Q.4 (a)** Explain in detail the selection procedure of rolling contact bearing from manufacturer's catalogue. **05**
- (b)** Design the following parts of a cast iron piston for a single acting four stroke engine for the below given data. **09**
(i) Piston Head (ii) Piston Skirt (iii) Piston Pin.
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 x 10³ kJ/kg, Speed=2000 rpm. Take for cast iron material σ_t =38 N/mm², Thermal conductivity (k)=46.6 W/m/⁰C and T_C - T_E=220 ⁰C.
- Q.5 (a)** Design a crane hook for lifting capacity of 5 tonnes. It is made from forged steel and has approximate triangular section. Take permissible tensile stress 80 N/mm² for forged steel. **07**
- (b)** Describe the basic objectives of material handling system. State the basic principles in selection of material handling equipment. **07**
- OR**
- Q.5 (a)** A ball bearing is operating on a work cycle consisting of three parts – a radial load of 3000 N at 1440 rpm for one quarter cycle, a radial load of 5000 N at 720 rpm for one half cycles, and radial load of 2500 N at 1440 rpm for the remaining cycle. The expected life of the bearing is 10000 h. Calculate the dynamic load carrying capacity of the bearing. **07**
- (b)** A 80 mm long journal bearing supports a load of 2800 N on a 50 mm diameter shaft. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 kg / m-s at the operating temperature. If the bearing is capable of dissipating 80 J/s, determine the maximum safe speed. **07**
