Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – SUMMER 2024

Subject Code:3171917 Date:28-05-2024

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. **Use of PSG design data book and VB Bhandari design data book is permitted.**

			MARKS
Q.1	**(a)**	What are the advantages and disadvantages of bushed-pin flexible coupling?	**03**
	(b)	It is required to standardize load-carrying capacities of dumpers in a manufacturing unit. The maximum and minimum capacities of such dumpers are 40 kN and 630 kN, respectively. The company is interested in developing seven models in this range. Specify their load carrying capacities.	**04**
	(c)	Design a muff coupling to connect two steel shafts transmitting 25 kW power at 360 rpm. The shafts and key are made of plain carbon steel 30C8 ($S_{yt} = S_{yc} = 400\ N/mm^2$). The sleeve is made of grey cast iron FG 200 ($S_{ut} = 200\ N/mm^2$). The factor of safety for the shafts and key is 4. For sleeve, the factor of safety is 6 based on ultimate tensile strength.	**07**
Q.2	**(a)**	What is the curvature effect in a helical spring? How does it vary spring index?	**03**
	(b)	Explain the laws of stepped regulations of speeds in multi-speed gearbox.	**04**
	(c)	It is required to design a helical compression spring subjected to a force of 500 N. The deflection of the spring corresponding to this force is approximately 20 mm. The spring index should be 6. The spring is made of cold-drawn steel wire with an ultimate tensile strength of 1000 N/mm^2. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength ($G = 81370\ N/mm^2$). Design the spring and calculate: (i) Wire diameter; (ii) Mean coil diameter; (iii) Number of active coils; (iv) Total number of coils; (v) Free length of the spring; (vi) Pitch of the coils; Assume a gap of 1 mm between adjacent coils under maximum load condition. Spring has square and ground ends.	**07**

OR

(c) A concentric spring consists of two helical compression springs one inside the other. The free length of the outer spring is 25 mm greater than the inner spring. The wire diameter and mean coil diameter of the inner spring are 8 and 64 mm respectively. Also, the wire diameter and mean coil diameter of the outer spring are 10 and 80 mm respectively. The number of active coils in the inner and outer springs is 10 and 15 respectively. Assume the same material for two springs and the modulus of rigidity of the spring material is 81370 N/mm^2. The composite spring is subjected to a maximum axial force of 1000 N. Calculate: **07**

(i) The stiffness of the spring when the deflection is from 0 to 25 mm.
(ii) The stiffness of the spring when the deflection is more than 25 mm.
(iii) The compression of each spring.
(iv) The force transmitted by each spring.
(v) The maximum torsional shear stress induced in each spring.

Q.3 **(a)** Define the following terms concerning rolling contact bearing: **03**
(i) Basic static load rating, (ii) Rating life and (iii) Reliability

(b) Comparison between sliding contact and rolling contact bearing. **04**

(c) A single-row deep groove ball bearing is subjected to a 30 second work cycle that consists of the following two parts: **07**

	Part I	Part II
Duration (s)	10	20
Radial load (kN)	50	20
Axial load (kN)	14	8
Speed (rpm)	800	1600

The static and dynamic load capacities of the ball bearing are 40 kN and 70kN respectively. Calculate the expected life of the bearing in hours.

OR

Q.3 **(a)** Why sliding contact bearings should not operate at bearing modulus? **03**

(b) Differentiate between Arithmetic, Geometric and Harmonic Progressions in case of design of gear box. **04**

(c) The following data are given for a 360° hydrodynamic bearing: **07**
Radial load = 3.2 kN
Journal speed = 1510 rpm
l/d ratio = 1
unit bearing pressure = 1.3 MPa
radial clearance = 0.05 mm
viscosity of lubricant = 25 cP
Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing. Calculate:

(i) Journal diameter and bearing length;
(ii) Coefficient of friction;
(iii) Power lost in friction;
(iv) Minimum oil film thickness;
(v) Flow requirement in litres/min;
(vi) Temperature rise

Q.4 **(a)** What is a herringbone gear? Where they are used? **03**

(b) A pair of parallel helical gears consists of 18 teeth pinion meshing with a 63 teeth gear. The normal module is 3 mm. The helix angle is 23° while the normal pressure angle is 20°. Calculate: **04**

(i) Transverse module;
(ii) Transverse pressure angle;
(iii) Axial pitch;
(iv) Pitch circle diameters of the pinion and the gear

(c) Two parallel shafts with center distance 200 mm are to be connected by 20° full depth spur gear and pinion for a speed ratio of 3:1. The speed of the pinion is 600 rpm. Module and width of the gear and pinion are 5 mm and 50 mm respectively. The safe static stresses for pinion and gear are 110 and 55 MPa respectively. Find maximum power that can be transmitted safely. Assume the following parameters for the design: **07**

Velocity factor, $K_v = \frac{6}{6+v}$
Factor of safety = 1.5;
Application factor, $K_a = 1.5$
Load distribution factor, $K_m = 1$

OR

Q.4 **(a)** Define the following terms used in worm gearing: **03**

(i) Lead;(ii) Lead angle; and (iii) Normal pitch

(b) A pair of worm gears is designated as 2/54/10/5. Calculate: **04**

(i) Center distance; (ii) Speed reduction; and (iii) Dimensions of the worm

(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 $14\frac{1}{2}^{\circ}$ composite form. The allowable static stress for both the gears is 55 MPa. If the pinion transmits 2.75 kW at 1100 rpm, 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/mm^2. Consider face width as 1/3rd of the slant height of the pitch cone and velocity factor $= \frac{6}{6+v}$ **07**

Q.5 **(a)** Explain valve gear mechanism of IC Engine. **03**

(b) Derive the thickness of a thick cylindrical shell made of brittle material subjected to internal pressure only. **04**

(c) A high-pressure compound cylinder consists of inner cylinder and outer jacket. The inner and outer diameters of the cylinder are 200 and 300 mm respectively. The outer diameter of jacket is 400 mm. The difference between the outer diameter of the cylinder and the inner diameter of the jacket before assembly is 0.25 mm (E=207 kN/mm^2). Calculate the shrinkage pressure and the maximum tensile stress induced in any of the cylinders. **07**

OR

Q.5 **(a)** What do you understand by 6 x 37 ropes? Explain with neat sketches the different rope sections. **03**

(b) Draw the speed diagrams for the following structure equations by assuming motor speed is greater than all spindle speeds: **04**

(i) z=3(3) 3(1); (ii) z=3(1) 2(3)

(c) Explain the design procedure of a crane hook having a trapezoidal section. **07**

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