Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV EXAMINATION – WINTER 2025

Subject Code:3144101 Date:18-11-2025

Subject Name:Design of Machine Elements and Transmission System

Time:02:30 PM TO 05:00 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.**

			MARKS
Q.1	**(a)**	Explain types of tolerances with suitable example.	**03**
	(b)	What is factor of safety? Enlist various factors while selection of factor of safety.	**04**
	(c)	Enlist various theories of failures? Explain maximum shear stress theory of failure.	**07**
Q.2	**(a)**	What is bolt of uniform strength?	**03**
	(b)	How a riveted joint fails? Explain with neat sketch.	**04**
	(c)	A double riveted lap joint with zig-zag riveting is to be designed for 13 mm thick plates. Assume σ_t = 80 MPa; τ = 60 MPa ; and σ_c = 120 MPa. State how the joint will fail and find the efficiency of the joint.	**07**
		OR	
	(c)	A propeller shaft is required to transmit 45 kW power at 500 rpm. It is a hollow shaft, having an inside diameter 0.6 times of outside diameter. It is made of plain carbon steel and the permissible shear stress is 84 N/mm^2. Calculate the inside and outside diameters of the shaft.	**07**
Q.3	**(a)**	What is Saddle key? Give its application.	**03**
	(b)	What is function of coupling? State its application.	**04**
	(c)	Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The service factor may be assumed as 1.35. The following permissible stresses may be used : Shear stress for shaft, bolt and key material = 40 MPa Crushing stress for bolt and key = 80 MPa Shear stress for cast iron = 8 MPa	**07**
		OR	
Q.3	**(a)**	State the advantages and limitations of welded joints over riveted joint.	**03**
	(b)	What is the difference between protected and unprotected rigid flange couplings?	**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 the sleeve, the factor of safety is 6 based on ultimate strength.	**07**
Q.4	**(a)**	List the types of flat belt drives.	**03**
	(b)	Sketch the cross-section of a V-belt and label its important parts.	**04**

(c) Design a rubber belt to drive a dynamo generating 20 kW at 2250 r.p.m. and fitted with a pulley 200 mm diameter. Assume dynamo efficiency to be 85%. **07**

Allowable stress for belt = 2.1 MPa
Assuming thickness of the belt, t = 10 mm
Density of rubber = 1000 kg / m^3
Angle of contact for dynamo pulley = 165°
Coefficient of friction between belt and pulley = 0.3

OR

Q.4 **(a)** Define the following terms used in gears. **03**
(1) Addendum (2) Circular pitch (3) Backlash

(b) Derive condition for constant velocity ratio of gears. **04**

(c) A 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 centre 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. Assuming steady load conditions and 8–10 hours of service per day, for that service factor is consider as unity. Take flexural endurance limit (σ_e) for cast iron is 84 MPa. **07**

Q.5 **(a)** Explain the following term with respect to spring. **03**
(1) Free length (2) Spring index (3) Spring rate

(b) A 150 mm diameter shaft supporting a load of 10 kN has a speed of 1500 r.p.m. The shaft runs in a bearing whose length is 1.5 times the shaft diameter. If the diametral clearance of the bearing is 0.15 mm and the absolute viscosity of the oil at the operating temperature is 0.011 kg/m-s, find the power wasted in friction. **04**

(c) It is required to design a helical compression spring subjected to a maximum force of 1250 N. The deflection of the spring corresponding to the maximum force should be approximately 30 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81370 N/mm^2 respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate: **07**
(a) wire diameter (b) mean coil diameter (c) number of active coils (d) total number of coils (e) free length of the spring (f) pitch of the coil.

OR

Q.5 **(a)** Explain the following terms used in bearing design. **03**
(1) Rating life of a bearing (2) Basic static load rating
(3) Sommerfeld Number

(b) What is used of leaf spring? List the materials commonly used for the manufacture of the leaf springs. **04**

(c) A pair of helical gears are to transmit 15 kW. The teeth are 20° stub in diametral plane and have a helix angle of 45°. The pinion runs at 10 000 rpm and has 80 mm pitch diameter. The gear has 320 mm pitch diameter. **07**

If the gears are made of cast steel having allowable static strength of 100 MPa; determine a suitable module and face width from static strength considerations and check the gears for wear, given σ_{es} = 618 MPa.

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