Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023

Subject Code:3141907 Date:13-07-2023

Subject Name:Fundamentals of Machine Design

Time:10:30 AM TO 01:00 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.**

Q.1	**(a)**	Derive the expression for polar moment of inertia of a circle using principle of integration.	**03**
	(b)	What is section modulus? Derive the expression of section modulus for rectangular section.	**04**
	(c)	Explain volumetric stress and volumetric strain. Derive the expression to find the change in volume of a rectangular bar subjected to 3D stresses.	**07**
Q.2	**(a)**	Explain the design considerations in casting process with neat sketch.	**03**
	(b)	Derive and explain the expression of polar modulus and polar moment of inertia of a solid shaft.	**04**
	(c)	Derive the expression for slope and deflection at the free end of a cantilever beam of length L carrying UDL of w kN/m throughout its length.	**07**
		OR	
	(c)	The maximum load on a petrol engine push rod 300 mm long is 1400 N. It is hollow having the outer diameter 1.25 times the inner diameter. Spherical seated bearings are used for the push rod. The modulus of elasticity for the material of the push rod is 210 kN / mm^2. Find a suitable size for the push rod, taking a factor of safety of 2.5.	**07**
Q.3	**(a)**	What is spline? Explain different types of splines.	**03**
	(b)	What is contact stress? Explain Hertz contact stress with suitable example.	**04**
	(c)	A steel wire of diameter d = 4 mm is bent around a cylindrical drum of radius R_o = 0.5 m, E = 200 GPa, σ_{pl} = 1200 MPa. Determine M and $\sigma_{max.}$	**07**
		OR	
Q.3	**(a)**	Explain different types of sections normally used in the design of levers.	**03**
	(b)	Explain the region of safety and boundaries for Maximum Principal Stress Theory under Bi-axial Stresses.	**04**
	(c)	Derive the expression of design of shaft subjected to combined twisting moment and bending moment with usual notations.	**07**
Q.4	**(a)**	State the limitations of Euler's formula for buckling load of a column.	**03**
	(b)	What is 'overhauling' of power screw? Explain the condition for overhauling and its application.	**04**
	(c)	Explain the design procedure for knuckle joint.	**07**
		OR	
Q.4	**(a)**	Justify that "Preloading improves the fatigue strength of bolted joint."	**03**
	(b)	Distinguish stress distribution in curved and straight beams.	**04**
	(c)	A masonry chimney of uniform circular section, 20 m high, with 5 m external diameter and 3 m internal diameter, has to withstand a horizontal wind	**07**

pressure of intensity 2 kN/m^2 of the projected area. Find the maximum and minimum stress intensities at the base. Given, density ρ of masonry structure = 21 kN/m^3.

Q.5 **(a)** Explain different types of Fatigue stresses with stress–time curves. **03**

(b) What is stress concentration? Explain the causes of stress concentration. **04**

(c) A double-threaded power screw is used to raise a load of 5 kN. The nominal diameter is 60 mm and the pitch is 9 mm. The threads are Acme type with $2\theta = 29°$ and the coefficient of friction at the screw threads is equal to 0.15. Neglecting collar friction, calculate: (i) The torque required for raising the load; (ii) The torque required to lower the load; and (iii) The efficiency of the screw for lifting load. **07**

OR

Q.5 **(a)** Explain the necessity of providing taper on cotter with the magnitude of a correct taper. **03**

(b) Explain cumulative fatigue damage with Minor's Equation. **04**

(c) The endurance strength for a part is 280 MPa while Su = 630 MPa. It is subjected to a loading as follows **07**

σ_{m1}= 315 MPa and σ_{v1} = 96 MPa for 80% of time

σ_{m2}= 245 MPa and σ_{v2} =145 MPa for 20% of time

Find the expected life in number of cycles of reversals. Assume K_t = 1.5.

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