U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Industrial Engineering and Management **Duration: 3 hrs.**
Course Code: 23IM4ESDME **Max Marks: 100**
Course: Design of Machine Elements

Instructions: 1.Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Design Data Hand Book is permitted.

				CO	PO	Marks
			UNIT – I			
	1	a)	What are Codes and Standards and how they are useful for design engineers?	*CO1*	*PO1*	**04**
		b)	Write clearly the statement of i. Maximum Normal Stress Theory and ii. Maximum Shear Stress Theory.	*CO1*	*PO1*	**04**
		c)	A rod of circular cross section is to sustain a torsional moment of 300kN-m and bending moment 200kN-m. Selecting 45C8 steel (σ_{yt} = 353MPa and assuming factor of safety =3, determine the diameter of the rod as per the following theories of failure i. Maximum Shear Stress Theory ii. Maximum Normal Stress Theory	*CO1*	*PO1* *PO2* *PO4*	**12**
			OR			
	2	a)	Explain clearly the Causes and Remedies for Stress Concentration with neat sketches.	*CO2*	*PO1*	**08**
		b)	A steel rod (SAE 9260 oil quenched σ_{ut}=1089.5MPa, σ_{yt}=689.4MPa, σ_{-1}=427.6MPa) is subjected to tensile load which varies from 120kN to 40kN. Design the safe diameter of the rod using "Soderberg Diagram". Adopt factor of safety as 2, stress concentration factor as unity and correction factor for load, size and surface as 0.75, 0.85 and 0.91 respectively.	*CO2*	*PO1* *PO2* *PO4*	**12**
			UNIT – II			
	3	a)	Design a socket and spigot type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses. σ_t = 100N/mm^2; σ_c = 150N/mm^2 and τ= 60N/mm^2.	*CO3*	*PO1* *PO2* *PO4*	**08**
		b	A cast iron flange coupling is to connect two shafts of 45mm diameter to transmit 20kW power at 400rpm. The permissible shear strength for the shaft, bolt and key is 50N/mm^2 and the permissible compressive stress is 120N/mm^2. The permissible shear strength for cast iron is 15n/mm^2. Assume starting torque as 30% more than the normal torque. Design the following components of the coupling: i. Shaft ii. Key iii. Bolt and iv. Hub.	*CO3*	*PO1* *PO2* *PO4*	**12**

			OR			
	4	a)	Design a socket and spigot type cotter joint to sustain an axial load of 80,000N. The material selected for the joint is C-40 steel. Take a factor of safety of 1.75	*CO3*	*PO1* *PO2* *PO4*	**10**
		b)	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	*CO3*	*PO1* *PO2* *PO4*	**10**
			UNIT – III			
	5	a)	Derive Lewis beam strength equation for Spur Gear.	*CO 2*	*PO1*	**06**
		b)	A pair of carefully cut (class-II) spur gear with pinion diameter 120mm transmits 20kW at 230rpm of the gear. Reduction ratio is 5:1. The pinion is made of cast steel heat treated with allowable stress 197MN/m^2. Gear is made of cast iron with allowable stress 56MN/m^2. Determine module, face width, and number of teeth on pinion and gear. Take pressure angle as 20^0 full depth involute.	*CO2*	*PO1* *PO2* *PO4*	**14**
			OR			
	6	a)	Design a pair of spur gear. It transmits 20KW from a shaft rotating at 750 rpm to a parallel shaft which is to rotate at 280 rpm. Assume number of teeth on pinion 28 and 20^0 full depth tooth form. The material for pinion is C40 steel untreated and for gear forged steel about 0.30% C untreated. Determine module & face width. Also, suggest suitable surface hardness for the weaker member based on dynamic & wear load considerations.	*CO2*	*PO1* *PO2* *PO4*	**20**
			UNIT – IV			
	7	a)	A transmission shaft carries a pulley midway between the two bearings. The bending moment at the pulley varies from 200Nm to 600Nm, as the torsional moment in the shaft varies from 70Nm to 200Nm. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of steel FeE400 (σ_{ut}=549 MPa, σ_{yt}= 400MPa). The corrected endurance limit of the shaft is 200N/mm^2. Using a factor of safety of 2, determine the diameter of shaft.	*CO3*	*PO1* *PO2* *PO4*	**20**
			OR			
	8	a)	A Shaft is supported by two bearings placed 1100 mm apart. A pulley of diameter 620 mm is keyed at 400 mm to the right from the left hand bearing and this drives a pulley directly below it with a maximum tension of 2.75 kN. Another pulley of diameter 400 mm is placed 200 mm to the left of right hand bearing and is driven with a motor placed horizontally to the right. The angle of contact of the pulley is 180^0 and μ=0.3. Find the diameter of the shaft. Assume K_b=3.0, K_t=2.5, σ_u=300 MPa, σ_y= 190MPa.	*CO3*	*PO1* *PO2* *PO4*	**20**

			UNIT – V			
	9	a)	Derive Petroff's equation for co-efficient of friction of a Hydrodynamic Bearing. Clearly mention the assumptions made.	*CO4*	*PO1*	**06**
		b)	A 75mm long full journal bearing of diameter 75mm supports a load of 10kN. The speed of the journal is 1200rpm. The absolute viscosity of the oil is 10^{-2} Pas and diametral clearance ratio is 0.001. Determine the co-efficient of friction by i) Petroff's equation and ii) Mckee's Equation.	*CO4*	*PO1* *PO2* *PO4*	**10**
		c)	What is Sommerfeld number? What is its application in designing Hydrodynamic Journal Bearing?	*CO4*	*PO1* *PO2* *PO4*	**04**
			OR			
	10		SAE 20 oil is used to lubricate a hydrodynamic journal bearing of diameter 75mm and length 75mm, oil enters at 40^0C. The journal rotates at 1200rpm. The diametral clearance is 75µm. Assume operating temperature of the oil as 53^0C and determine a) Magnitude and location of the minimum oil film thickness b) Power loss c) Oil flow through the bearing d) Side leakage	*CO4*	*PO1* *PO2* *PO4*	**20**

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