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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Industrial and Production Engineering

Semester End Examination; Feb. - 2021

Design of Machine Elements

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Describe the theories of failures and determine the dimensions of mechanical components subjected to different types of static load.

CO2: Compute the dimensions of the machine elements subjected to fatigue and impact loads.

CO3: Distinguish between different mechanical joints and design welded and riveted joints for various loads.

CO4: Design spur gear and different types of spring for different applications.

CO5: Design the shaft for different load condition and comprehend the mechanism of lubrication and compare design of bearing for different applications.

Note: ***I) PART - A*** *is compulsory.* ***Two*** *marks for each question.*

II) PART - B*: Answer any* ***Two*** *sub questions (from a, b, c) for Maximum of* ***18 marks*** *from each unit.*

III) *Use of machine design data hand book is permitted.* ***IV)*** *Assume suitable missing data if any.*

Q. No.	Questions	Marks	BLs	COs	POs
	PART - A	**10**			
1 a.	Define stress concentration and stress concentration factor.	2	L1	CO1	PO1
b.	Define mean stress and stress amplitude.	2	L1	CO2	PO1
c.	Define the terms transverse pitch and diagonal pitch used in riveted joints.	2	L1	CO3	PO1
d.	Mention any two advantages and disadvantages of gear drive.	2	L1	CO4	PO1
e.	Define viscosity and bearing modulus.	2	L1	CO5	PO1
	PART - B	**90**			
	UNIT - I	**18**			
1 a.	Explain the factors influencing machine design.	9	L2	CO1	PO2
b.	A mild steel shaft 60 mm diameter is subjected to a bending moment of 25 x 10^5 N-mm and torque *T*. If the yield point of steel in tension is 230 N/mm^2, find the maximum value of this torque without causing yielding of the shaft according to: i) Maximum principal stress theory ii) Maximum shear stress theory iii) Maximum distortion energy theory Adopt a FOS of 1.5	9	L3	CO1	PO3
c.	A machine element is loaded as shown in Fig. 1(c). Determine a safe value for the thickness of the plate. Material selected for the machine element has design stress of 200 MPa.	9	L3	CO1	PO3

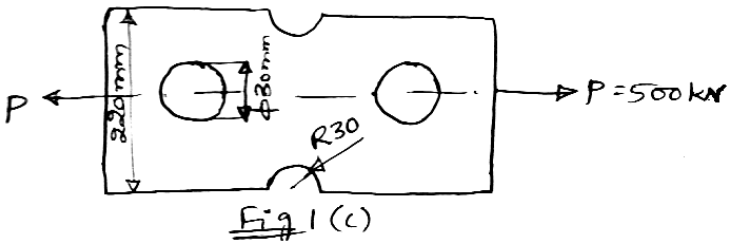

Fig 1 (c)

Contd… 2

UNIT - II **18**

2 a. A cantilever beam made of cold drawn carbon steel of circular cross-section as shown in Fig. 2(a) subjected to a load which varies from *–F* and *3F*. Determine the maximum load that this member can withstand by using both Soderberg and Goodman criteria for an indefinite life using a factor of safety of 2. The theoretical stress concentration factor is 1.42 and the notch sensitivity is 0.9. Assume the following values:

Ultimate stress = 550 MPa

Yield stress = 470 MPa

Endurance Limit = 275 MPa

Size factor = 0.85

Surface factor = 0.89

15 L3 CO2 PO3

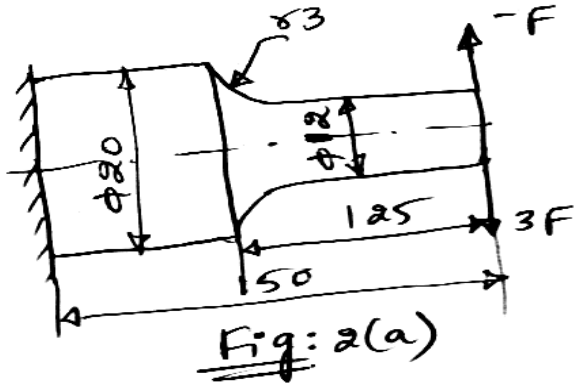

Fig: 2(a)

b. A cold drawn steel rod of circular section is subjected to a variable bending moment of 565 N-m to 1130 N-m as the axial load varies from 4500 N to 13500 N. The maximum bending moment occurs at the same instant that the axial load is maximum. Determine the required diameter of the rod for a factor of safety of 2. Neglect stress concentration and column effect.

Take; σ_u = 550 MPa, σ_y = 470 MPa, endurance limit as 50% of the ultimate strength and size and surface correction coefficient as 0.85 and 0.85 respectively. 3 L2 CO2 PO2

c. Differentiate between high cycle fatigue and low cycle fatigue. 3 L2 CO2 PO2

UNIT - III **18**

3 a. Design a double riveted butt joint with two cover plates for the longitudinal beam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 75% allowable tensile stress in the plate of 90 MPa, allowable compressive stress of 140 MPa and an allowable shear stress in the rivets as 56 MPa. Assume chain type of riveting. 10 L3 CO3 PO3

b. Explain different modes of failure in riveted joint with sketch. 8 L2 CO3 PO3

c. Derive an expression for strength of traverse fillet welded joint. 8 L4 CO3 PO4

Contd….3

UNIT - IV **18**

4 a.	In a spur gear arrangement a pinion made of cast steel is rotating at 900 rpm and is driving a cast iron gear at 150 rpm. The teeth are to have standard 20° stub involute profiles and the maximum power to be transmitted is 25 kW. Determine the module, face width, tangential tooth load and dynamic load. The pinion has 16 teeth with surface hardness of 250 BHN, take static stress for pinion as 103 MPa and for gear as 55 MPa. Assume E_p = 96 GN/m^2 and E_G = 207 GN/m^2, K = 10, C_V = 0.5.	12	L3	CO4	PO3
b.	Design a helical compression spring for a maximum load of 1000 N and for a deflection of 25 mm. The maximum permissible shear stress for the spring wire is 420 N/mm^2, modulus of rigidity is 0.84 x 10^5 N/mm^2 and value of spring index is 6.	12	L3	CO4	PO3
c.	Derive Lewis equation.	6	L4	CO4	PO4

UNIT - V **18**

5 a.	Derive an equation for the shaft subjected to combined bending and twisting moments.	6	L4	CO5	PO4
b.	A power transmission shaft is supported in bearings 2 m apart and carries a pulley weighting 1 kN at its mid part and it receives power by a belt drive. The shaft transmits power to another machine by means of a flexible coupling just outside the right bearing. The power transmitted is 20 kW at 120 rpm. The ratio of belt tensions is 3:1. Estimate the size of the shaft, if the permissible stress in shear is 54 N/mm^2. Take C_m and C_t as 1.5 and the pulley diameter is 200 mm.	12	L3	CO5	PO3
c.	A shaft running at 900 rpm is supported by bearings of 50 mm diameter and 75 m length. The bearing operates in still air at 30°C. The oil has a viscosity of 0.013 pa-s at 130°C, while the diametral clearance is 0.05mm. Determine the permissible load on the bearing and the power lost if no artificial cooling is used.	12	L3	CO5	PO3

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