Course Code: 20ME0314 **R20**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR
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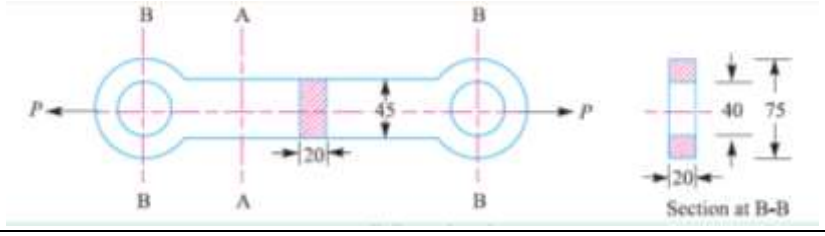
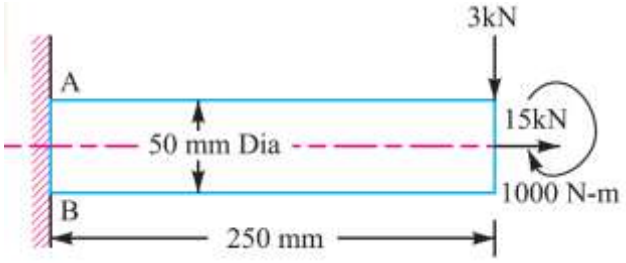
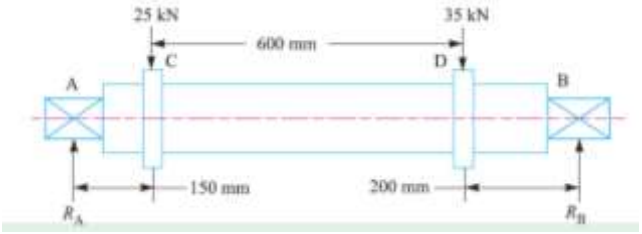
QUESTION BANK (DESCRIPTIVE)

Subject with Code: DME-I (20ME0314) **Course & Branch**: B.TECH &ME

Year & Sem: III &I

UNIT –I
Introduction & Stress in Machine Members

1	**a.** How do you classify materials for engineering use?	[L1][CO1]	**[06M]**
	b. Draw and Explain the stress–strain diagram for mild steel.	[L2][CO1]	**[06M]**
2	**a.** How do you classify the machine design? Explain.	[L1][CO1]	**[06M]**
	b. Describe the general design procedure while designing a machine element	[L2][CO1]	**[06M]**
3	**a.** List out the general design consideration to be followed while designing a machine element.	[L1][CO1]	**[06M]**
	b. Identify various manufacturing consideration to be followed in designing a machine element.	[L1][CO1]	**[06M]**
4	**a.** Define preferred numbers and explain its applications.	[L1][CO1]	**[06M]**
	b. What is meant by factor of safety? Explain how it can be used in design applications.	[L1][CO1]	**[06M]**
5	**a.** A cast iron link, as shown in Fig. is required to transmit a steady tensile load of 45 kN. Find the tensile stress induced in the link material at sections A-A and B-B. 	[L3][CO1]	**[06M]**
	b. A hydraulic press exerts a total load of 3.5 MN. This load is carried by two steel rods, supporting the upper head of the press. If the safe stress is 85 MPa and E = 210 kN/mm2, find : 1. diameter of the rods, and 2. extension in each rod in a length of 2.5m.	[L3][CO1]	**[06M]**
6	A shaft, as shown in Fig. is subjected to a bending load of 3 kN, pure torque of 1000 N-m and an axial pulling force of 15 kN. Calculate the stresses at A and B. 	[L3][CO1]	**[12M]**
7	**a.** Derive an expression for the impact stress induced due to a falling load	[L3][CO1]	**[06M]**
	b. An unknown weight falls through 10 mm on a collar rigidly attached to the lower end of a vertical bar 3 m long and 600 mm^2 in section. If the maximum instantaneous extension is known to be 2 mm, Find the corresponding stress and the value of unknown weight? Take E = 200 kN/mm^2.	[L3][CO1]	**[06M]**
8	**a.** Explain the bending stress relation and draw the diagram.	[L2][CO1]	**[06M]**
	b. A pump lever rocking shaft is shown in Fig. The pump lever exerts forces of 25 kN	[L3][CO1]	**[06M]**

	and 35 kN concentrated at 150 mm and 200 mm from the left and right hand bearing respectively. Find the diameter of the central portion of the shaft, if the stress is not to exceed 100 MPa 		
9	A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 120 N-m, simultaneously, it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses.	[L4][CO1]	**[12M]**
10	**a.** Derive an expression for the shear stress developed in a shaft, when it is subjected to torsion.	[L3][CO1]	**[4M]**
	b. A hollow shaft is required to transmit 600 kW at 110 r.p.m., the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and twist in a length of 3 metres not to exceed 1.4 degrees. Find the external diameter of the shaft, if the internal diameter to the external diameter is 3/8. Take modulus of rigidity as 84 GPa.	[L4][CO1]	**[8M]**

UNIT –II
Introduction & Stress in Machine Members

1	**a.** What is meant by factor of safety? Explain how it can be used in design applications**.**	[L2][CO2]	**[6M]**
	b. Describe the following theories of failures in detail (i) Rankine's theory (ii) Guest's or Tresca's theory (iii) Saint Venant theory	[L2][CO2]	**[6M]**
2	The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory 2.Maximum shear stress theory 3.Maximum principal strain theory 4.Maximum strain energy theory; and 5.Maximum distortion energy theory.	[L3][CO2]	**[12M]**
3	A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to 1. the maximum principal stress; 2. The maximum shear stress; and 3. the maximum distortion strain energy theory of yielding.	[L3][CO2]	**[12M]**
4	**a.** List various theories of failures and discuss about them in brief.	[L2][CO2]	**[6M]**
	b. A mild steel rod of 12 mm diameter was tested for tensile strength with the gauge length of 60 mm. Following observations were recorded : Final length = 80 mm; Final diameter = 7 mm; Yield load = 3.4 kN and Ultimate load = 6.1 kN. Calculate: 1. Yield stress, 2. Ultimate tensile stress, 3. Percentage reduction in area, and 4. Percentage elongation.	[L4][CO2]	**[6M]**
5	Cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using two different theories of failure, and assuming a factor of safety of 2. Take E = 210 GPa and poisson's ratio = 0.25.	[L3][CO2]	**[12M]**
6	**a.** What is the notch sensitivity? And also write the expression for it.	[L1][CO2]	**[04M]**
	b. Find the maximum stress induced in the following cases taking stress concentration into account:	[L3][CO2]	**[08M]**

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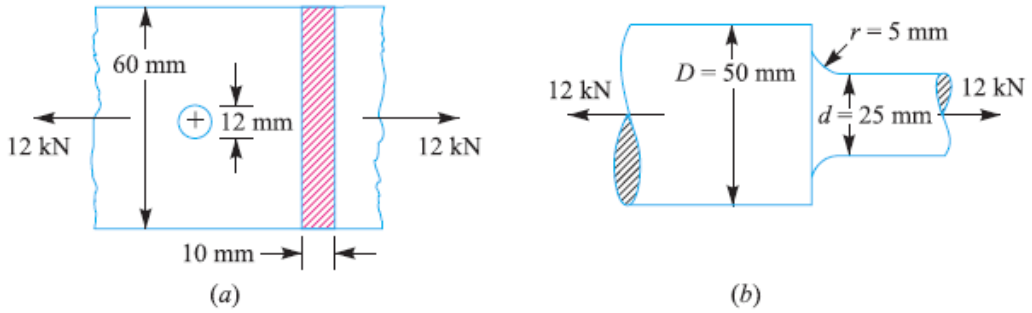
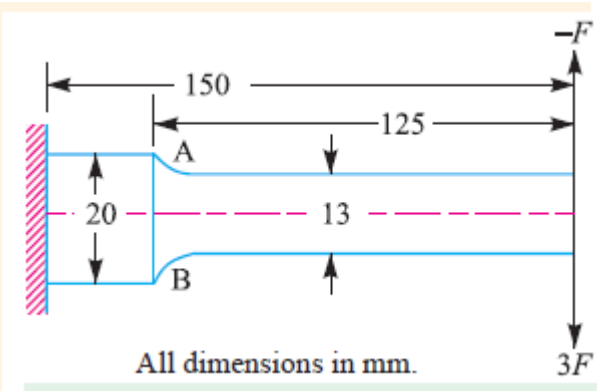
	1. A rectangular plate 60 mm × 10 mm with a hole 12 diameter as shown in Fig. (a) and subjected to a tensile load of 12 kN. 2. A stepped shaft as shown in Fig. (b) and carrying a tensile load of 12 kN.  		
7	a. Illustrate how the stress concentration in a component can be reduced.	[L2][CO2]	**[4M]**
	b. Explain Goodman's and Soderberg's equation for combination stresses	[L2][CO2]	**[8M]**
8	Cantilever beam made of cold drawn carbon steel of circular cross-section as shown in Fig. Is subjected to a load which varies from – F to 3 F. Determine the maximum load that this member can withstand for an indefinite life using a factor of safety as 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 finish factor= 0.89  	[L3][CO2]	**[12M]**
9	A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m^2 and – 150 MN/m^2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2.	[L3][CO2]	**[12M]**
10	A hot rolled steel shaft is subjected to a torsional moment that varies from 330 N.m clockwise to 110 N.m counter clockwise and an applied bending moment at a critical section varies from 440N-m to-220 N-m. The shaft is of uniform cross-section and no key way is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MN/m^2 and yield strength of 410 MN/m^2.Take the endurance limit as half the ultimate strength, factor of safety of 2, size factor of 0.85 and surface finish factor of 0.62.	[L3][CO2]	**[12M]**

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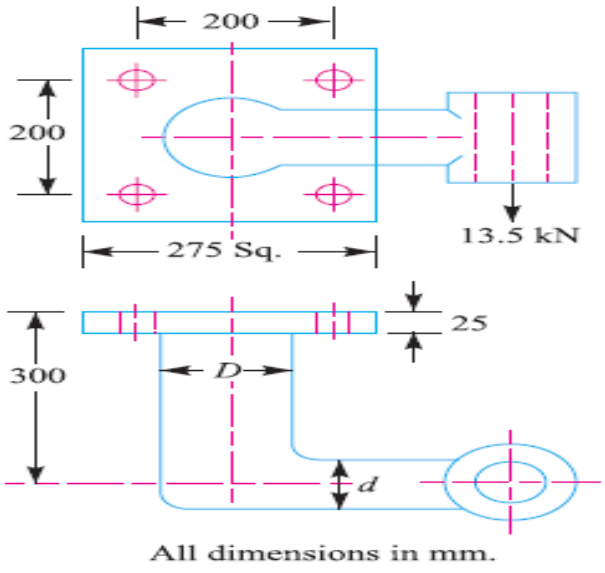
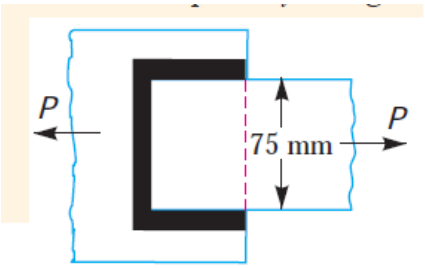
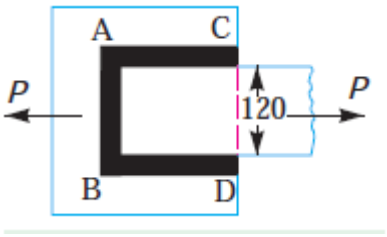
UNIT –III
Design of Bolted Joints & Design of Welded Joints

1	**a.** List out the important terms used in screw threads with a neat sketch.	[L1][CO3]	**[06M]**
	b. Describe the initial stresses induced in screw fasteners due to screwing up forces.	[L2][CO3]	**[06M]**
2	**a.** Explain Stress in screw fasteners due to Combined Forces?	[L2][CO3]	**[06M]**
	b. Two machine parts are fastened together tightly by means of a 24 mm tap bolt. If the load tending to separate these parts is neglected, find the stress that is set up in the bolt by the initial tightening.	[L3][CO3]	**[06M]**
3	**a.** Discuss on bolts of uniform strength with practical applications of such bolts.	[L2][CO3]	**[06M]**
	b. A lever loaded safety valve has a diameter of 100 mm and the blow off pressure is 1.6 N/mm^2. The fulcrum of the lever is screwed into the cast iron body of the cover. Find the diameter of the threaded part of the fulcrum if the permissible tensile stress is limited to 50 MPa and the leverage ratio is 8.	[L3][CO3]	**[06M]**
4	Derive an expression for eccentric load acting parallel to the axis of bolts	[L3][CO3]	**[12M]**
5	The following Fig. Shows a solid forged bracket to carry a vertical load of 13.5 kN applied through the centre of hole. The square flange is secured to the flat side of a vertical stanchion through four bolts. Calculate suitable diameter D and d for the arms of the bracket, if the permissible stresses are 110 MPa in tension and 65 MPa in shear. Estimate also the tensile load on each top bolt and the maximum shearing force on each bolt. 	[L4][CO3]	**[12M]**
6	**a.** List out the merits and demerits of welded joint over riveted joints	[L1][CO3]	**[06M]**
	b. Draw the standard welding symbol and also mention its application.	[L2][CO3]	**[06M]**
7	**a.** What are the advantages of preloading bolted joints?	[L1][CO3]	**[02M]**
	b. A steam engine of effective diameter 300 mm is subjected to a steam pressure of 1.5 N/mm^2. The cylinder head is connected by 8 bolts having yield point 330 MPa and endurance limit at 240 MPa. The bolts are tightened with an initial preload of 1.5 times the steam load. A soft copper gasket is used to make the joint leak-proof. Assuming a factor of safety 2, find the size of bolt required. The stiffness factor for copper gasket may be taken as 0.5.	[L3][CO3]	**[10M]**
8	**a.** What is an eccentric loaded welded joint? Discuss the procedure for designing such a joint	[L2][CO3]	**[06M]**
	b. A plate 100 mm wide and 10 mm thick is to be welded to another plate by means of double parallel fillets. The plates are subjected to a static load of 80 kN. Find the length of weld if the permissible shear stress in the weld does not exceed 55 MPa.	[L3][CO3]	**[06M]**

9	A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Fig. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading 	[L3][CO3]	**[06M]**
10	Determine the length of the weld run for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by means of 1. A single transverse weld; and 2. Double parallel fillet welds when the joint is subjected to variable loads. 	[L4][CO3]	**[12M]**

UNIT –IV
Design of Shafts & Design of Cotters and Knuckle Joints

1	a. Classify the type of stresses induced in shafts?	[L2][CO4]	**[05M]**
	b. A solid circular shaft is subjected to a bending moment of 3000 N-m and a torque of 10 000 N-m. The shaft is made of 45 C 8 steel having ultimate tensile stress of 700 MPa and a ultimate shear stress of 500 MPa. Assuming a factor of safety as 6, determine the diameter of the shaft.	[L3][CO4]	**[07M]**
2	A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley...	[L3][CO4]	**[12M]**
3	A steel solid shaft transmitting 15 kW at 200 r.p.m. is supported on two bearings 750 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below. Using an allowable stress of 54 MPa in shear, determine the diameter of the shaft.	[L3][CO4]	**[12M]**
4	a. How the shaft is designed when it is subjected to twisting moment only?	[L1][CO4]	**[06M]**
	b.A shaft made of mild steel is required to transmit 100 kW at 300 r.p.m. The supported length of the shaft is 3 metres. It carries two pulleys each weighing 1500 N supported at a distance of 1 metre from the ends respectively. Assuming the safe value of stress, determine the diameter of the shaft.	[L3][CO4]	**[06M]**

5	a. A solid shaft is transmitting 1 MW at 240 r.p.m. Determine the diameter of the shaft if the maximum torque transmitted exceeds the mean torque by 20%. Take the maximum allowable shear stress as 60 MPa.	[L3][CO4]	**[06M]**
	b. A steel spindle transmits 4 kW at 800 r.p.m. The angular deflection should not exceed 0.25° per metre of the spindle. If the modulus of rigidity for the material of the spindle is 84 GPa, find the diameter of the spindle and the shear stress induced in the spindle.	[L3][CO4]	**[06M]**
6	Design and draw a cotter joint to support a load varying from 30 kN in compression to 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 50 MPa; shear stress = 35 MPa and crushing stress = 90 MPa.	[L3][CO5]	**[12M]**
7	Design a gib and cottor joint to carry a maximum load of 35 kN. Assuming that the gib, cotter and rod are of same material and have the following allowable stresses : σ_t = 20 MPa ; τ = 15 MPa ; and σ_c = 50 MPa.	[L3][CO5]	**[12M]**
8	**a.**List out the applications of a cotter joint?	[L1][CO5]	**[04M]**
	b. A knuckle joint is required to withstand a tensile load of 25 kN. Design the joint if the permissible stresses are :σ_t= 56 MPa ; τ = 40 MPa and σ_c= 70 MPa.	[L3][CO5]	**[08M]**
9	Design a sleeve and cotter joint to resist a tensile load of 60 kN. All parts of the joint are made of the same material with the following allowable stresses: Tensile stress = 60 MPa; shear stress = 70 MPa; and compressive stress = 125 MPa.	[L3][CO5]	**[12M]**
10	Design a knuckle joint to transmit 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression.	[L3][CO5]	**[12M]**

UNIT –V
Design of Keys & Design of Couplings

1	**a.** What is a key? State its function with neat sketch.	[L1][CO6]	**[06M]**
	b. Design the rectangular key for a shaft of 50 mm diameter. The shearing and crushing stresses for the key material are 42 MPa and 70 MPa.	[L3][CO6]	**[06M]**
2	How are the keys classified? Draw neat sketches of different types of keys and state their applications.	[L1][CO6]	**[12M]**
3	**a.**What is the effect of keyway cut into the shaft?	[L1][CO6]	**[06M]**
	b. A 45 mm diameter shaft is made of steel with yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with yield strength of 340 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2.	[L3][CO6]	**[06M]**
4	Describe, with the help of neat sketches, the types of various shaft couplings mentioning the uses of each type.	[L2][CO6]	**[12M]**
5	**a**. What are the forces acting on sunk key? Explain with neat sketch	[L2][CO6]	**[4M]**
	b. A 15 kW, 960 r.p.m. motor has a mild steel shaft of 40 mm diameter and the extension being 75 mm. The permissible shear and crushing stresses for the mild steel key are 56 MPa and 112 MPa. Design the keyway in the motor shaft extension. Check the shear strength of the key against the normal strength of the shaft.	[L3][CO6]	**[08M]**
6	**a.** Discuss the function of a coupling. Give at least three practical applications.	[L2][CO6]	**[06M]**
	b. Design and make a neat dimensioned sketch of a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.	[L3][CO6]	**[06M]**
7	Design and draw a clamp coupling to transmit 30 kW at 100 r.p.m. The allowable	[L3][CO6]	**[12M]**

	shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves are six. The permissible tensile stress for the bolts is 70 MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3.		
8	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 Draw a neat sketch of the coupling.	[L3][CO6]	**[12M]**
9	Design and draw a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250 r.p.m. The allowable shear stress in the shaft is 40 MPa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in the coupling bolts is 30 MPa.	[L3][CO6]	**[12M]**
10	Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 r.p.m. The overall torque is 20 percent more than mean torque.The material properties are as follows : (a) The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively. (b) The allowable shear stress for cast iron is 15 MPa. (c) The allowable bearing pressure for rubber bush is 0.8 N/mm^2. (d) The material of the pin is same as that of shaft and key. Draw neat sketch of the coupling.	[L3][CO6]	**[12M]**

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